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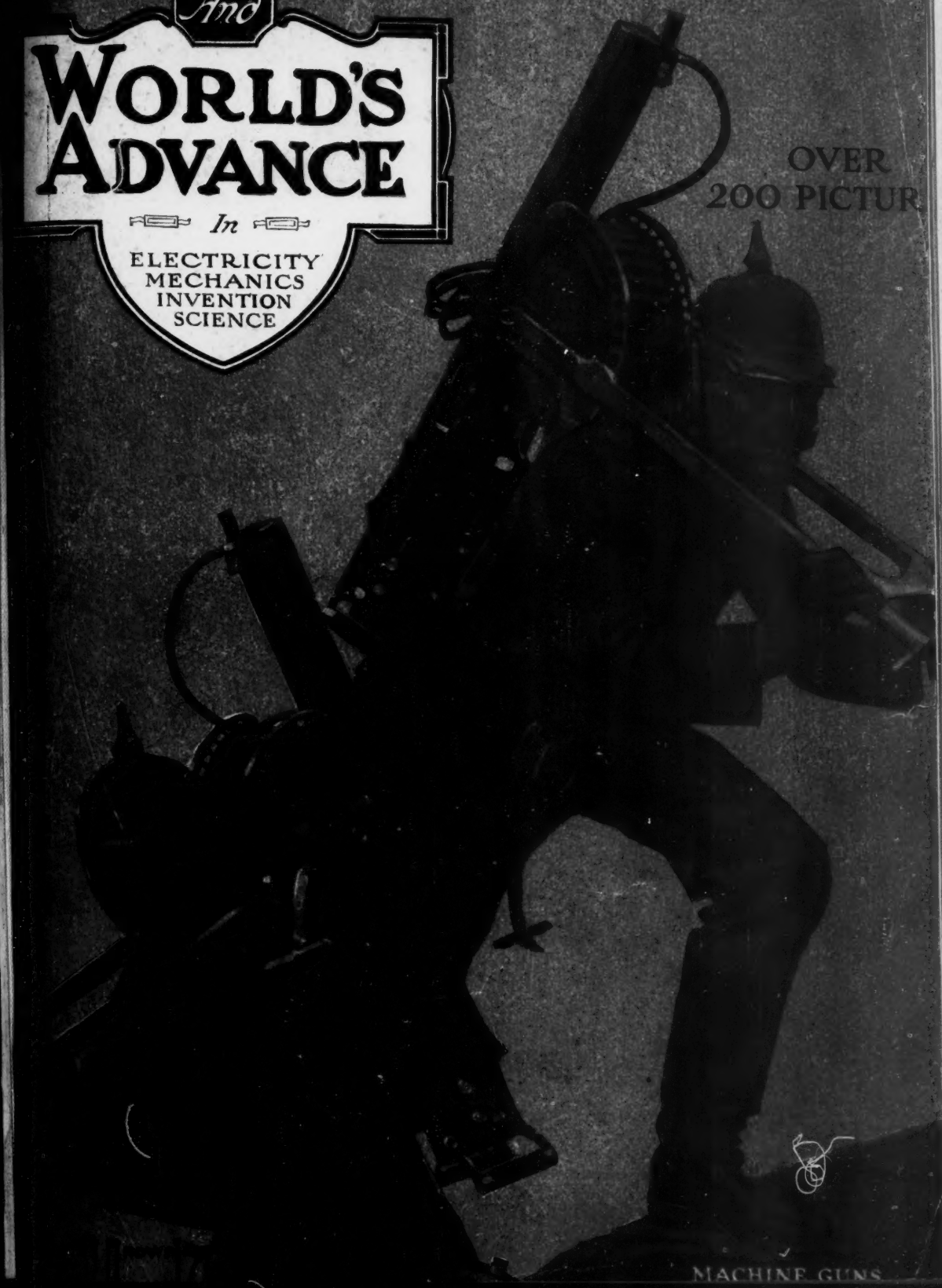

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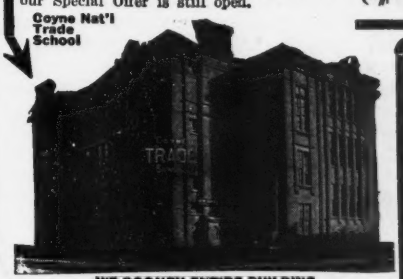

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POPULAR SCIENCE MONTHLY
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Volume LXXXVII — No. 4

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POPULAR SCIENCE MONTHLY
AND
WORLD'S ADVANCE

Vol. 87. *October,* 1915 No. 4

Two Important Events for the World's Advance

WITH this issue the WORLD'S ADVANCE and the POPULAR SCIENCE MONTHLY, founded in 1872, the oldest monthly in America devoted to the popularization of science, are combined.

Beginning with the November issue, Waldemar Kaempffert—perhaps the best known writer of popular science subjects in America, and for the past fifteen years Managing Editor for the *Scientific American*—becomes the Editor of the POPULAR SCIENCE MONTHLY AND WORLD'S ADVANCE.

All the features of the WORLD'S ADVANCE which have proved most popular will be retained. Wireless amateurs may turn to the "Radio Section" as in the past, and know that they are receiving the latest wireless news and the best practical information on wireless. Those who have profited by the "'Practical Worker" and the "Home Craftsman" departments will continue to receive helpful suggestions for the making of useful articles. All these departments will henceforth be edited by the most competent men obtainable. In fact, they will be more useful and stimulating than ever.

The POPULAR SCIENCE MONTHLY AND WORLD'S ADVANCE will present to its readers the new, the practical, and the unusual in modern science, mechanics, and electricity. It will strive to be a fascinatingly interesting, easily grasped, and trustworthy monthly record of the latest achievements in science, invention and industry.

The November issue will contain over 140 pages of illustrated articles and three hundred pictures of the most varied kind.

Contributions from our readers are solicited by your new Editor and by the new publishers. They will be paid for at regular rates on acceptance.

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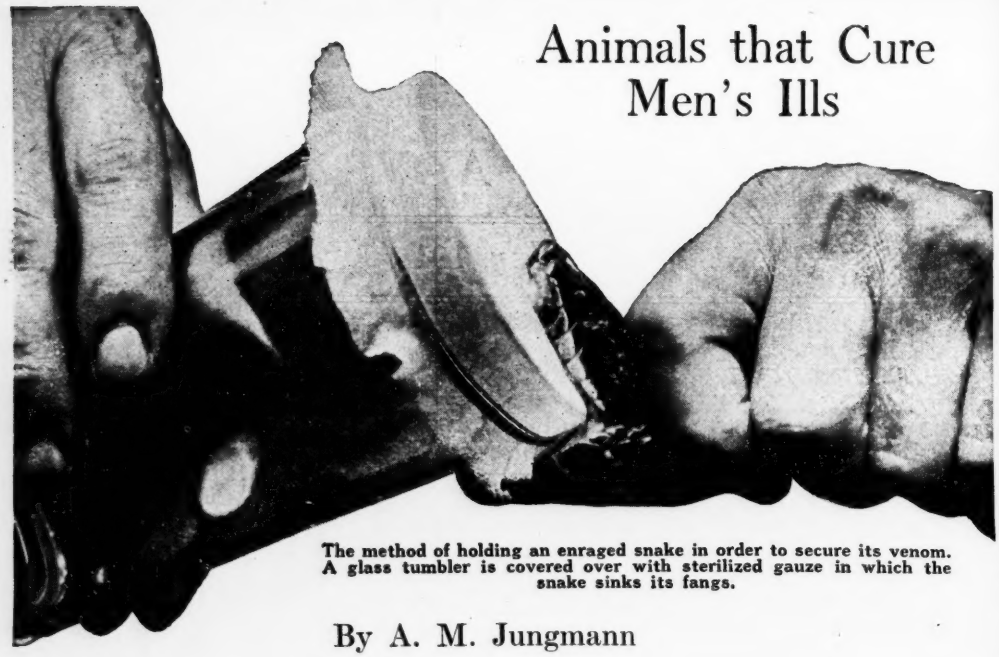
Animals that Cure Men's Ills



The method of holding an enraged snake in order to secure its venom. A glass tumbler is covered over with sterilized gauze in which the snake sinks its fangs.

By A. M. Jungmann

THANKS to modern science, animals are not merely beasts of burden or purveyors of pelts. Although it is not generally known, animals have been of peculiar service in assisting man to prevent and combat disease and to overcome the effects of poisons.

Even the dreaded poisonous snake has become the means of saving many thousands of persons yearly from death due to snake bites. Through the great advancement in the knowledge of antivenomous serum-therapeutics in the last few years it is now possible to overcome the effects of venomous snake bites through the injection of antivenomous serum into the snake's victim.

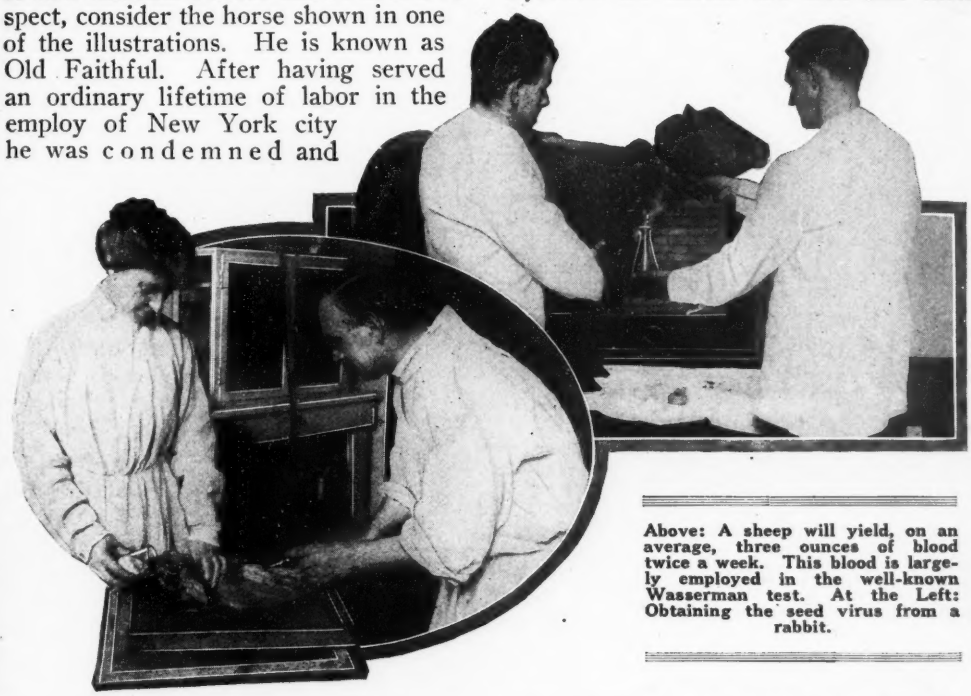
Certain snakes thrive in captivity while others refuse food and are kept alive with difficulty. A snake that refuses food must be artificially fed, and it is not possible to obtain as much venom from such a one as it is from one that will eat of its own volition. The snake picture at the head of this page is one of those which take kindly to captivity. It is a moccasin snake that has been in the Reptile House in the Bronx Park Zoölogical Gardens for several years. When the venom is to be extracted the snake is taken from its cage, thrown upon the floor and, before it has had time to strike, a cane is held over the back of its neck. It is then seized firmly just behind the head while the body and tail are held under the arm. The snake is now thoroughly enraged and ready to strike. It is offered a glass tumbler covered with absorbent gauze, and into this it sinks its fangs with a vengeance. As soon as the snake takes hold of the glass the poison glands are gently pressed and all the venom they contain is forced out. The snake yields between thirty and forty drops of venom. Extracting venom from poisonous snakes requires coolness and skill, but Mr. Charles E. Snyder who held the snake shown, regards it as all in the day's work.

It would be possible for this moccasin to yield twenty-eight ounces of venom if it were extracted once a week and the average yield were 35 drops, because a moccasin is expected to live about seven years in captivity.

Antivenomous serum is obtained from horses. The horse is vaccinated with the snake venom, beginning with a very small amount and gradually increasing the amounts over a period of sixteen months.

The serum is sufficiently antitoxic when the horse will tolerate 2 grammes of dry venom in a single injection. Dr. Calmette has been very successful in preparing serum from cobra venom in this manner. Twelve days after the last injection of venom the horse is ready to be bled. In a space of ten days he will give 20 litres of blood. Then, after a three months' rest, the animal is ready to have the operation repeated.

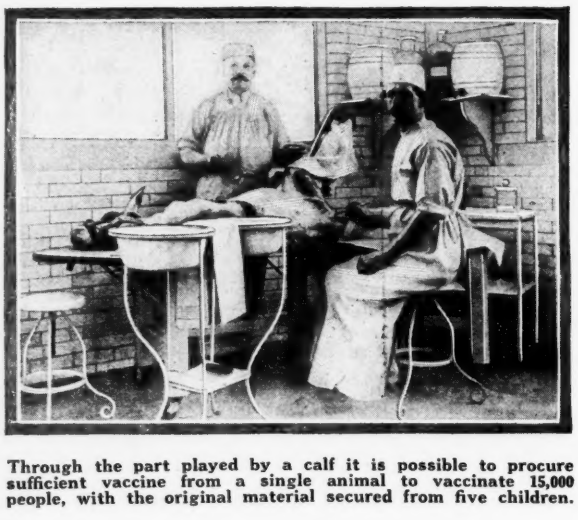
The horse has been of the greatest service to man in furnishing sera. Not only has this animal been the means of giving us antivenomous serum, but he has provided sera for use in combating tetanus and diphtheria. As an example of how efficient a horse can be in this respect, consider the horse shown in one of the illustrations. He is known as Old Faithful. After having served an ordinary lifetime of labor in the employ of New York city he was condemned and sent to Otisville, where the city maintains a laboratory for the production of sera. This horse being found to be in excellent health, although too old to continue the work he had been accustomed to doing and therefore considered valueless in a monetary way, was sent to the laboratory. To date he has given the City of New York $175,000 worth of diphtheria antitoxin.



Above: A sheep will yield, on an average, three ounces of blood twice a week. This blood is largely employed in the well-known Wasserman test. At the Left: Obtaining the seed virus from a rabbit.

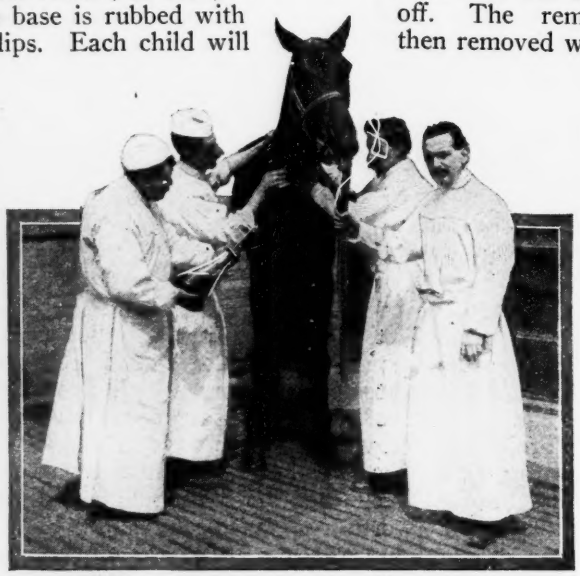
Diphtheria antitoxin is produced by taking a virulent culture and growing it in broth for a week. The culture, after rigid tests for purity, is rendered sterile by the addition of 10 per cent. of a 5 per cent. solution of carbolic acid. In 48 hours the dead bacilli will have settled on the bottom of the container and the clear fluid is filtered off and kept in a cool place until required. Horses are then injected with enough of this toxin to kill five thousand guinea pigs. From three to five days afterwards a second injection is given the horse. At intervals of from five to eight days thereafter pure toxin is injected until at the end of two months the dose has been increased from ten to twenty times. After six weeks or two months from the first injection the horses are bled and their serum tested. Horses that are found to give less than the desired number of units per cubic centimeter are discarded. The horses which are retained receive increasing doses on an average of from three days to one week. At the end of three months the antitoxin serum of the horses should contain over 300 units per cubic centimeter. Some horses have been known to give over 1000 units, but none has been known to give as much as 2000 units per cubic centimeter. At in-

tervals of every nine months the horses are given a three months' vacation, during which time no inoculations of any kind are given. In this way the horses are kept in good condition. The strength of the antitoxin is tested on guinea pigs. For example, when ten fatal doses of toxin are mixed with one-tenth of the amount of antitoxin used with 100 fatal doses, the guinea pig will remain in its normal state of health.



Through the part played by a calf it is possible to procure sufficient vaccine from a single animal to vaccinate 15,000 people, with the original material secured from five children.

The service of the calf to man does not end with giving him leather and veal. The calf has been of inestimable value in combating smallpox. In preparing smallpox vaccine five children who have never been vaccinated are vaccinated in the usual way. Five days after vaccination the top of the vesicle, or scar, is removed and the base is rubbed with sterilized bone slips. Each child will serve to charge both sides of from one hundred to two hundred slips. The slips are then placed in a sterilized box and kept in cold storage. They will retain their usefulness for from two to three weeks. This is known as obtaining seed virus. Rabbits are also used for obtaining the necessary seed virus. The calf which is to be inoculated is first thoroughly cleaned and its hair clipped. The calf should be from two to four months of age and preferably a female. Before vaccination the calf is thrown on a table and its posterior abdomen and the insides of its thighs carefully washed and sterilized. About one hundred scarifications are then made on the sterilized area. The vaccinated places are from one-quarter to one-half of a square inch. Each scarification, or place wherein the vaccine is to be rubbed, should be separated from another by about three-quarters of an inch. On the fifth or sixth day from the time the calf was vaccinated the vaccine vesicles should be ready for collection. The vaccinated area is again thoroughly sterilized and the crusts are picked off. The remaining pulp is then removed with a curette and made into an emulsion, which is placed in vials. Ivory slips are also charged from the vesicles.



This is Old Faithful, a horse that has already given the City of New York over $175,000 worth of diphtheria antitoxin.

The materials collected from the original five children may be sufficient to vaccinate fifteen calves Ten grammes of pulp and two hundred charged slips may be obtained from

each calf. In short, from the original five children, enough vaccine should be produced to vaccinate fifteen hundred persons. One calf has been known to yield sufficient vaccine to vaccinate ten thousand persons.

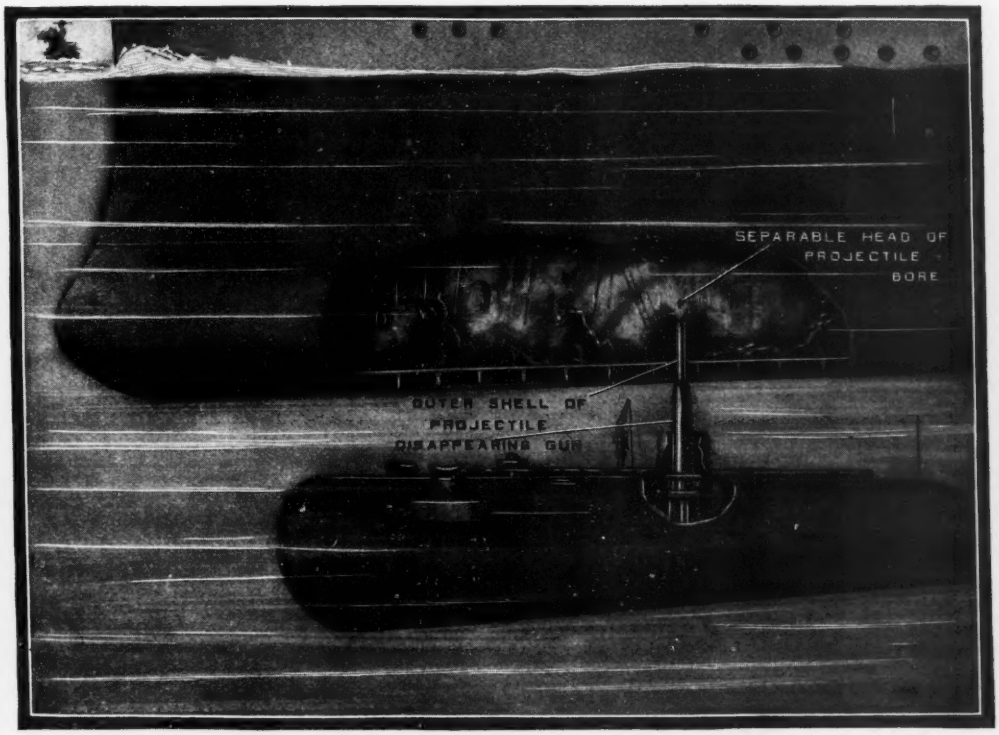
It has been found that when an animal is subjected to repeated injections with red blood cells of another species it will produce substances in its serum which will dissolve the foreign blood cells. Wasserman used this principle in his famous "Wasserman test." For this purpose a sheep is used. A sheep will yield, on an average, three ounces of blood twice a week for about two years.

All the animals used for these purposes are given the best of care, for they must be in excellent physical condition. Every effort is made to accomplish the operations painlessly. It is safe to assume that many an animal suffers more physical discomfort because it is improperly cared for in the ordinary pursuits than do the animals used in laboratories for the production of sera.

A Poisonous Submarine

The United States Patent Office recently granted a patent to Carl N. Wheaton for an invention which it prosaically calls "means for conducting submarine warfare," but which is in truth an extraordinary revelation of the possibilities of the human imagination run riot.

Torpedoes were apparently too harmless for this inventor. So he conceived the idea of asphyxiating the entire crew



Not satisfied with the deadly efficiency of modern torpedoes as used by submarine boats, an inventor has suggested a plan of using a gun to shoot poison gases into the hulls of hostile warships. The plan is to asphyxiate the crew of the warship without causing any material damage. But is the suggestion practicable?

of a battleship. He was not inspired by the use of chlorine gas in the present war; for according to his patent papers he filed his application over eight years ago. It is his idea to bring a submarine directly beneath the battleship and drive a hollow pin or projectile right through her bottom. Through the bore of the projectile a deadly gas is to be poured. He suggests, too, that a timed bomb can be attached to the head of the projectile, which is made separable so that the submarine can retire and watch results.

No naval officer would take this invention seriously. In time of war, fleets of battleships are carefully guarded by whole chains of submarine mines and cordons of torpedo boats. There is no chance for a submarine captain to glue himself to the bottom of a battleship. And on the high seas the feat would be still more difficult. Once it dives below the surface a submarine is blind; its periscope is retracted and it cannot see. What is more, the speed of a submarine on the surface is about twelve knots and the speed of a modern battleship anywhere from twenty to twenty-five knots. The submarine would be in a position of a snail trying to bite a greyhound.

A Non-Blinding Automobile Headlight

Headlight dimming or controlling devices have appeared in considerable number recently, but few have succeeded in passing the official tests of the Board of Headlight Inspection of Maryland, which has taken up the question of highway protection in a vigorous manner. One of the latest to receive the approval of the Board is the non-blinding device illustrated herewith.

Uninterrupted passage of the rays of light is permitted only when they are horizontal. All rays reflected in an upward direction are caught by the tilted section of the "lattice work," reflected first downward and then outward in a horizontal direction. A few rays are permitted to escape downward, directly in front of the car, where they increase the light thrown on the road. Not a single ray can blind the eye of a pedestrian or driver in an approaching car.

The glare of any automobile headlight can be eliminated by using a simple device consisting of concentric metal strips.

The device consists of a series of concentric rings, made of metal and covered with the usual mirror silvering. It is placed in the headlight back of the glass, being protected from dirt and dust.

Electric Power from Thunder-Clouds

Ever since men knew these two things —that the energy displayed in a thunderstorm is electric, and that electricity may be utilized—they have wondered if there was no way of preventing so much power from going to waste. Occasionally a bold inventor tries to harness the storm as we have already harnessed the cataract. His task is similar to that of utilizing the energy of the gunpowder exploded in a battle. The energy is there, but the problem is to control it. We need a motor that will run with a current of high intensity and small volume.

Such a motor, it appears, is that invented by a Russian, N. P. Michkine. Whether he has entirely solved the problem is, of course, another question.

The quantity of electricity stored in the atmosphere may be estimated by the effects sometimes produced by lightning.

But clouds that carry electric charges are only, so to speak, greater centers of accumulation for the electricity which in ordinary weather is spread throughout the atmosphere.

We know that electric discharges also manifest themselves by heat effects. There are numerous cases of telegraph wires melted by lightning. At the meteorological observatory of Pavlovsk, Russia, when a balloon was about to be released, an electric discharge, passing from a cloud to the earth, completely volatilized a steel wire one-thirtieth of an inch in diameter, that held it. The remarkable thing was that the atmospheric state indicated only a slight tendency toward the production of a thunder-storm.

Experiments in similar conditions, made by Kohlrausch, a German physicist, show that at the moment of a lightning discharge a copper conductor one-fifth of an inch in diameter may be melted.

Now Michkine has used these data to calculate the quantity of energy contained in a cloud, and has concluded that it amounts to at least enough to run an eight and one-half horse power motor for one hour. Hence, if we could utilize the energy wasted in a thunder-storm—energy that probably exists in the atmosphere at other times also—we should have a most valuable source of power. Although its energy is great, the electricity in a cloud possesses this energy largely by virtue of its high tension, for the actual volume of current in a discharge is small, just as the energy of a rifle bullet is due more to its velocity than to the small mass of lead composing it. If we are to utilize the energy of atmospheric electricity, therefore, we must have a motor that will work with a small volume of current. This motor Michkine believes he has invented.

The world's copper production amounted to 893,085 tons last year, most of which is consumed by the electrical industry. A large amount of the copper production has been utilized in the making of ammunition for the fighting nations.

Concrete Piles and a New Way of Sinking Them

Concrete has for many years been steadily usurping the place of wood in numerous forms of construction. One of the uses to which this versatile material has been put is in the concrete pile.

An exceedingly successful concrete pile, which has only recently been put on the market, is put into the ground in a novel manner. A collapsible steel core, exactly the size and shape of the completed pile, is surrounded with a reinforced steel shell, which is driven into the ground by a steam hammer to the desired depth. The core is then removed, leaving the steel shell in the ground. This, if found upon examination to be perfect, is filled with concrete and the work is completed. Such piles have been subjected to the severest tests and the results have been highly satisfactory. The steel shell holds the concrete to the proper shape while it is hardening, and prevents any deterioration caused by contact with the earth while the concrete is still soft. The piles are tapered and able to sustain great loads with very little settling. One pile seven-

A sectional view of a new type of concrete pile of novel design. The steel shell, which not only protects the concrete filling but also acts as the reinforcing agent, is first sunk into the ground, after which the concrete is poured in and allowed to harden.

A sectional view showing the method employed in driving the steel shell of a new concrete pile into the ground. The shell is temporarily provided with a collapsible core, which is subsequently removed when the desired depth has been reached.

teen feet and nine inches long, sustained a load of 120,000 pounds, with an actual settlement of but one-tenth of an inch. The original cost of these piles is somewhat higher than those of wood, but it is claimed that in the end they are many times cheaper.

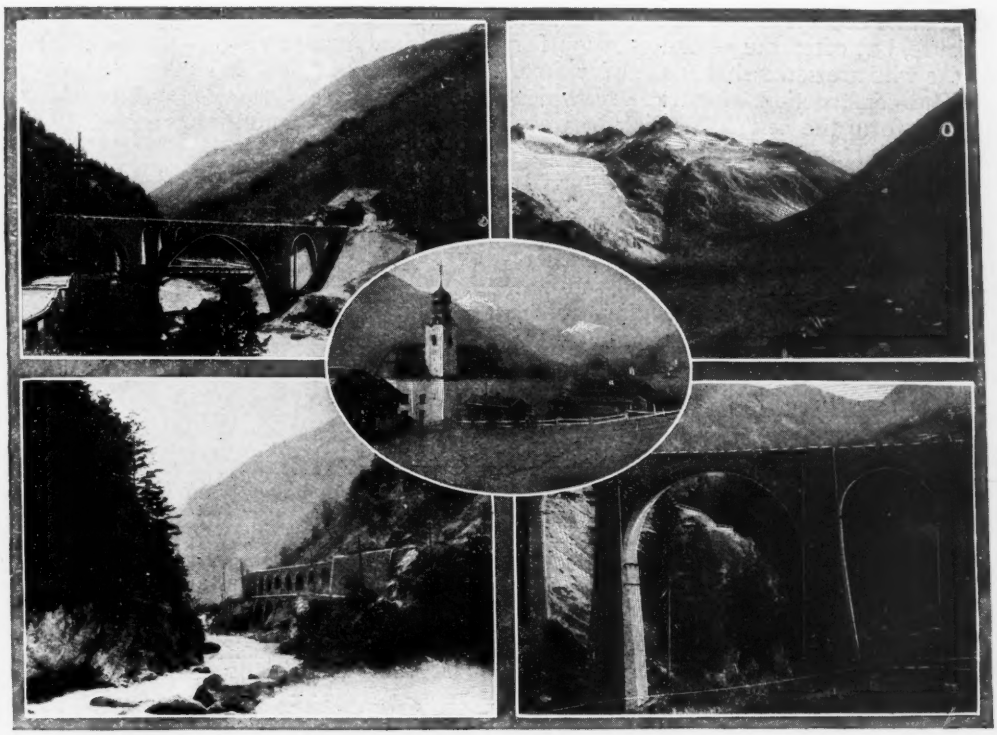
The manufacturers of this pile claim that it is absolutely permanent—a feature which, if true, will result in the total disuse of wood piles in time. The piles are not subject to decay or to the attacks of wood borers and destroyers. Piles of this type which have been dug up after having borne heavy loads for a number of years, have been found to be as perfect as the day they were driven into the ground.

The Furka Railway of Switzerland

By M. Widmer

WHEN the Simplon Line was inaugurated in 1906 there was probably no other city in the Rhone Valley which derived greater benefits through this feat than Brig, a delightfully quaint community at the junction of the Simplon and Furka post routes. A few years later—to be exact, in the summer of 1913—a second gigantic undertaking, the celebrated Lötschberg Railway, opened another new era for this fortunate district, and where it formerly required a long railway journey via Montreux and Spiez to reach Interlaken, or a trying drive via Gletsch to Meiringen, followed by a train and boat trip to Interlaken, this modern Alpine road takes a short cut through the huge, rocky mass of the Bernese Alps, to Kandersteg, Spiez, Berne and Interlaken.

The Simplon Railway forms the international highway from the Lake of Geneva and the Rhone Valley to Italy, while the Lötschberg Line, connecting with the Simplon route at Brig, has brought the Rhone Valley and the Bernese Oberland in direct communication. There remained now one other Alpine Pass, the Furka, which had no train service and which in a distance of 42½ miles runs from Brig to Andermatt, at the foot of the Oberalp Pass. From Andermatt—which will shortly be connected with Göschenen on the Gothard Line by a 2½ miles long electric railway, running close to the road through



A collection of views along the route of the new Furka Railway of Switzerland, which connects the towns of Brig and Andermatt. The railway is 42½ miles long and employs steam traction. It incorporates 50 viaducts, bridges and galleries, 7 tunnels and 5 loop tunnels.

the Schöllenen—the Oberalp Pass, practically a continuation of the Furka road, leads to Disentis, an ancient monastic village with recently discovered radio-active mineral springs, a distance of eighteen miles. From Disentis the Rhaetian Railway affords direct communication with all the noted Grisons resorts.

To cover this entire distance of 60½ miles requires a journey of one day between Brig and Andermatt and 4½ hours between Andermatt and Disentis—a fascinating drive for the tourist who is fortunate enough to be able to travel with leisure, but often out of the question for those who are somewhat rushed for time.

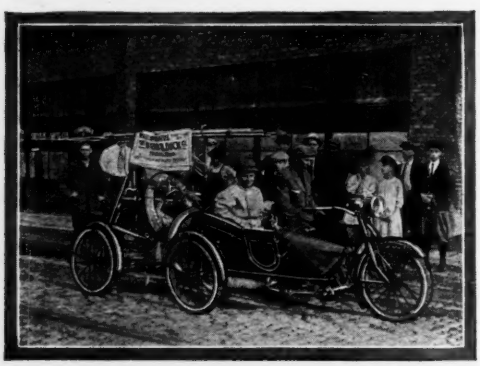
The construction of a railway which would form the connecting link between Brig and Disentis came up for discussion a number of years ago, and the construction of the line was started in 1911. On June 30, 1914, the inauguration of the first section, Brig-Gletsch, took place, but four weeks later, when the railroad was actually ready for regular traffic, the European war broke out, and in view of the completely reversed conditions it was decided that the line would only be opened for the summer season of 1915. The trip by rail from Brig to Gletsch takes two hours; the sections Gletsch-Andermatt, Andermatt-Göschenen and Andermatt-Disentis, which will also be open for traffic in the near future, require 1½ hours, ½ hour and 1½ hours, respectively. The new Alpine Railway will thus cover the total distance of 60½ miles in five hours.

The new railway has steam traction. It is a narrow gauge line, with rack and pinion sections, and possesses an extraordinary number of interesting features from an engineering point of view. There are over 50 viaducts, bridges and galleries; seven tunnels and five loop tunnels. The maximum gradient is 110 per cent., and the total length of the rack and pinion sections is 19½ miles. It is estimated that the cost of construction for the line Brig-Gletsch-Disentis is over $7,600,000.

The Victoria Falls, of the Zambesi River, in South Central Africa, are capable of furnishing 35,000,000 horse-power of electrical energy.

From Albany to the Panama-Pacific Exposition on a Motorcycle

In an outfit consisting of a motorcycle with a side-car attachment containing a complete wireless set, Mr. and Mrs. Robert Wengatz, of Albany, N. Y., started for the Panama-Pacific Exposition, to compete for the prize offered by the officials of the Exposition for the most novel method of crossing the continent. They are to be joined by Fred Wallace, also of Albany, who is an expert wireless operator. En route, they intend to keep in constant communication with important stations.

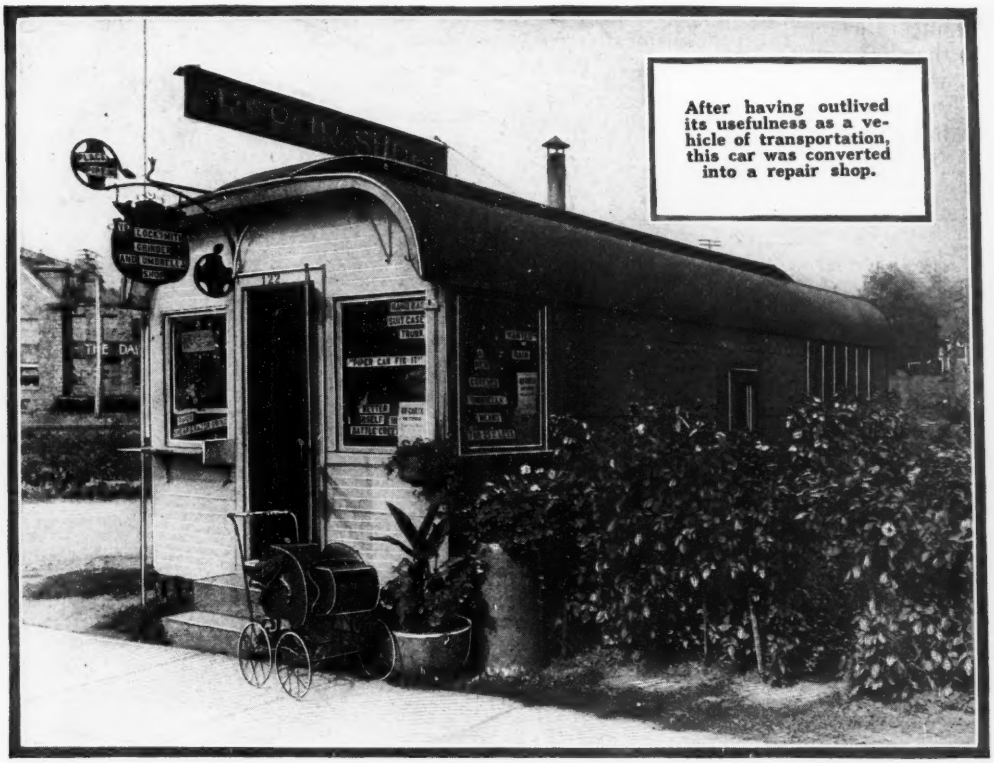


They will be in constant touch with important wireless stations on their trip from the East to the Panama-Pacfic Exposition.

The travelers hope that the war will end in the autumn, so that they can make a tour of the world by motorcycle.

Vineclad Pittsburgh—The Triumph of Foliage Over Smoke

The bald and smoke-ruined hills of the great iron city are to become vine-clad, tree-crested and brilliant-hued. This seems like magic, but the superin-



After having outlived its usefulness as a vehicle of transportation, this car was converted into a repair shop.

tendent of parks has imported from Asia Minor large quantities of lycium vine which will cover the bare slopes with the beautiful red foliage. It is able to resist smoke and fog and will not starve on poor soil. Of the native plants sumac and locust have done the best fighting against the Pittsburgh atmosphere and they are to be used extensively on the hilltops.

Converting a Street Car Into a Stationary Repair Shop

A street car that long ago outlived its usefulness as a vehicle of transportation is now made to perform useful service as a repair shop on one of the principal streets of Battle Creek, Michigan.

Five years ago, the ex-street car was hauled into its present position and placed on a brick foundation. The interior was remodeled so that more space was obtained—space ample enough for a workshop in the rear and a display window in the front.

The shop, liberally decorated with signs and bordered by a well-kept bed of flowers, attracts the attention of all who pass.

Surprise Signals to Test Locomotive Engineers

To train locomotive engineers so that they will not fail to see signals, some roads constantly use test or surprise signals.

Signals are flashed which compel the engineer to slow up or to stop without any reason. If the engineer fails to see the signal he is told at the end of his trip that at a certain point and a certain moment of his run he failed to obey a signal. Thus admonished he is made more alert. The training is continued until it becomes practically impossible for the engineer to pass signals without heeding them.

Such testing is regarded by many railroad men as a necessity. It keeps the

engineers ever on the watch for signals, so that in a moment of real danger there is no likelihood of a failure to act properly. Some psychologists assert that the training makes it impossible for the men to fall into the habit of noticing certain stereotyped signals, and not recognizing others.

Teaching Office Boys Their Job

Office boys, too long the butt of baseball and funeral jokes, are beginning to be recognized as a vital, necessary factor in the business organizations of the country and are being trained in their duties in much the same fashion as stenographers and bookkeepers. There are big opportunities ahead of every office boy, but nine out of ten are almost totally unprepared for their duties.

The first school for office boys was launched in New York as a part of the Y. M. C. A. work for boys. M. Marvin Jackson, in charge of the employment bureau for boys in the West Side Young Men's Christian Association, is the moving factor in the new school.

The course of study keeps pupils busy. They are taught how to run errands so as to cut down mileage and time, warned against wayside loitering while on errands, made to wrap packages neatly and securely, shown how to operate a telephone switchboard, instructed to give the soft answer that turneth away wrath from the lips of the nervous inquirer at the other end of the wire, and taught how to clean ink-wells and sharpen pencils and empty waste baskets, manipulate adding machines, typewriters and copying machines. They are made acquainted with filing systems and the proper methods of addressing envelopes.

An office boy school is a most modern institution. Heretofore, the boys fresh from school lacked the practical training that makes them of immediate value to their employers.

"The Portmanteau"—A Theater That Travels With Its Actors

A complete theater, which may be packed into ten boxes and sent to any part of the country, has been recently opened to the public in New York. The entire equipment of the "Portmanteau," as it has been aptly named by its inventor, Mr. Walker Stuart, of New York, weighs but three thousand pounds. It can be set up in two and one-half hours and repacked in about one hour.

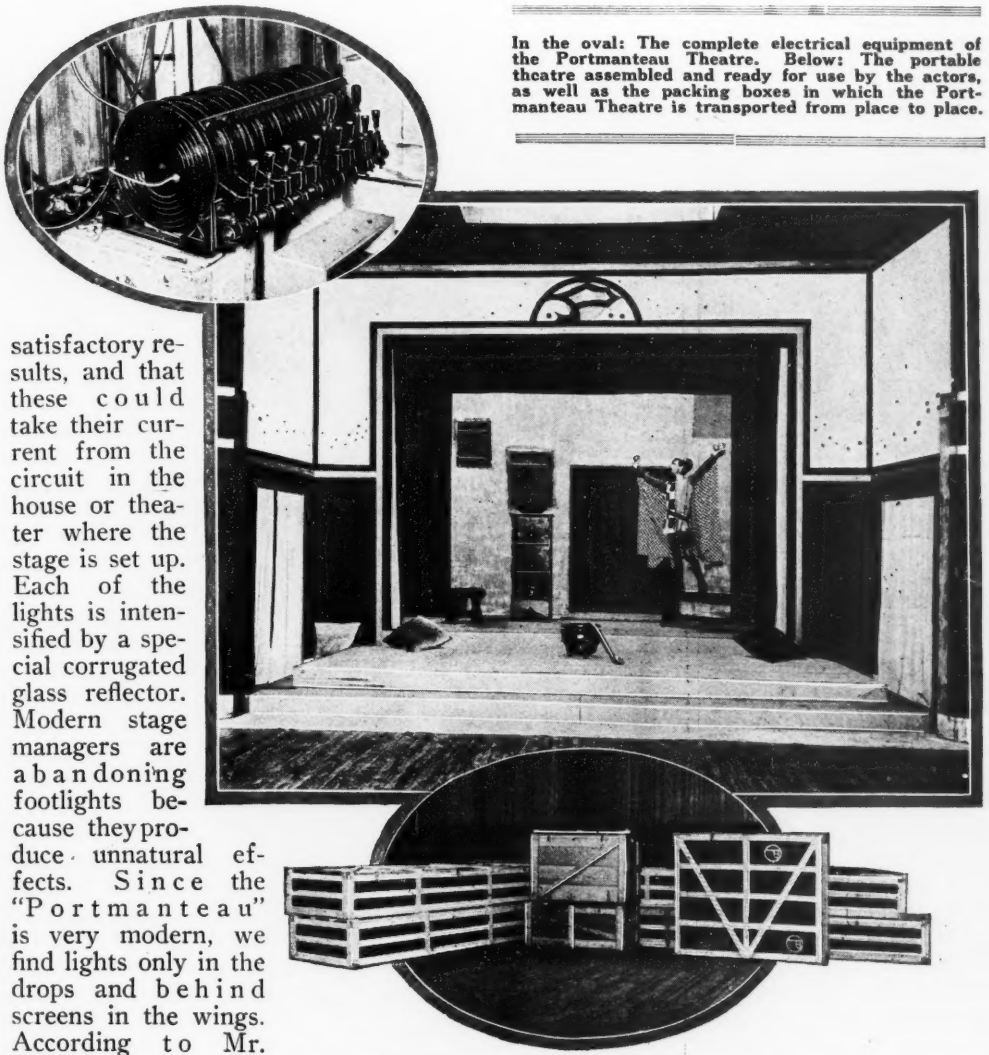
This little theater may be mounted in the gymnasium or auditorium of any school, club or settlement, in the ballroom of a private house, or in the open upon the lawn.

Small though it is, the stage of the little theater offers plenty of room for the sixteen actors and actresses who are to accompany the "Portmanteau" on its travels. The fore-stage is eighteen feet long and six feet deep; the main stage is twenty-two feet wide and twelve feet deep; the proscenium opening is sixteen feet wide and twelve high.

Much difficulty was found in providing a suitable lighting system. It was found that forty-two bulbs would give satisfactory results, and that these could take their current from the circuit in the house or theater where the stage is set up. Each of the lights is intensified by a special corrugated glass reflector. Modern stage managers are abandoning footlights because they produce unnatural effects. Since the "Portmanteau" is very modern, we find lights only in the drops and behind screens in the wings. According to Mr. Stuart, the system is most satisfactory.

The scenery is made of fibreboard, held on supports of wood, and all of it has been made fireproof. The arches and struts, although they may be taken apart and packed for transportation, are joined so perfectly that they will bear the weight of a man without straining the joints.

Hardly is an invention complete when improvements suggest themselves. Mr. Stuart hopes to substitute metal frames for the wooden supports, with the result that his theater will be even lighter than it is now, as well as stronger.



In the oval: The complete electrical equipment of the Portmanteau Theatre. Below: The portable theatre assembled and ready for use by the actors, as well as the packing boxes in which the Portmanteau Theatre is transported from place to place.

Two Telephone Systems Cause Much Confusion in Rochester, N. Y.

Physicians in Rochester, N. Y., are fighting for a single system of telephones. There are in Rochester at the present moment two competing companies, and the doctors claim that through the confusion of these systems much valuable time is lost in emergencies.

A simple pressure of the foot opens the lid of this improved garbage can, which is both sanitary and convenient.

A Buried Garbage Can Opened by the Foot

To lighten the drudgery of housework and to improve the sanitary condition of the kitchen, an underground waste can has been invented. It lessens the work of the maid or housekeeper. Press on a plate with your foot and the can's lid opens. Remove your foot and the cover springs back into place, so that stray hungry dogs are foiled in their attempt to satisfy their appetite by tipping the can.

How is the garbage collected? An iron frame fits snugly around an inner receptacle. The receptacle is lifted from the frame and the garbage is dumped into the collecting cart.

New Fashions in Furniture Casters

Millions of furniture casters are made of leather. To produce them, disks of the required size are cut out and cemented and compressed to form the wheel. Disks of metal are clamped on each side to serve as bearings for the axle that runs through the wheel. Such casters are made for use on hardwood floors. Similar casters of compressed felt are manufactured for the same purpose.

Among other styles of casters may be mentioned those of glass, designed to serve as insulators; ball-bearing casters, with no wheel at all, but instead a ball which, when the furniture is moved, revolves on a circle of smaller balls within the caster fitting; and lastly, caster wheels made of porcelain and of rubber, of lignum vitae, and other hard woods.

What Street Is This? — Look at the Curbstone

Street signs that can be read as plainly by night as by day have been installed in San Francisco. A waterproofed and protected cast-iron box, forty inches long and eight inches deep, is set into the curbstone six or eight feet from the corner of the sidewalk. Within the box is an electric tube light, connected with the regular street lighting system. The outer side of the box is perforated with letters spelling the name of the street. What is more, the names are placed exactly in position to meet the eye of the passing pedestrian, the autoist or the street car passenger, during the day or night.

An electrically-illuminated sign installed in the curbstone indicates the name of the street by day as well as by night.

Winding among the canyons and summits of the Rocky Mountains, this automobile road reaches an altitude of 8,500 feet above sea level. It has been built by private capital for the sole use of automobiles. Due to its narrowness, it is possible for automobiles to pass each other only at certain points where the road is sufficiently widened.

A Wonderful Automobile Road in the Rocky Mountains

Extending from Manitou, Colorado, to Crystal Park is one of the finest automobile roads in North America, an engineering triumph as well as a wonderful scenic highway. This road, winding among the canyons and summits of the Rocky Mountains, rises to an altitude of 8,500 feet above sea level, climbing up steadily from the city more than two thousand one hundred feet in fifteen miles.

Only automobiles are allowed to pass over this route. It was built for automobiles by private capital. Much of the way has been carved or blasted out of the granite of the everlasting hills. Over the lower slopes the course has been run in most tortuous curves in order to maintain an easy grade. In one single piece of ground, having only thirty acres of area, is a mile of looped and tangled roadway, forming a perfect maze of highway. Thus a maximum grade of only eight per cent. is secured, a road which is perfectly safe and easy for the biggest machines.

Because of the narrow way it is impossible for motors to pass, except at designated points. Hence the machines going down must wait for the ascending vehicles. This makes it essential to maintain a perfect schedule for the cars.

The Short-Lived Pin

Scientific curiosity has led a French investigator to look into the old question of the fate of the ordinary brass pin. By a series of experiments conducted on his own estate he discovered that pins, like human beings, go their way and are resolved into dust. Hair pins, which the experimenter observed for one hundred and fifty-four days, disappeared at the end of that period, having been converted into a ferrous oxide, a brownish rust, which was blown away by the winds.

Bright pins took nearly eighteen months to disappear; polished steel

needles nearly two years and a half; brass pins had but little endurance; steel pens at the end of eighteen months were nearly gone, while their wooden holders were still intact. Pencils suffered little by exposure.

A Tower That Fools the Eye

What form of building would be the unsafest to the eye, and yet the safest in reality? That seems to have been the whimsical problem that Professor Kohnke, of Dantzig, set himself to solve. The result is the amazing observation tower of Koslin, Germany, compared with which the famous leaning tower of Pisa is tame and almost uninteresting.

While this tower appears to be anything but safe, it is so constructed that it compares favorably with any conventional structure. It is built of reinforced concrete.

Although it apparently lurches up and out in a drunken way, the staircase leading to the top stands as a monument to the strength and adaptability of reinforced concrete—the material of which the tower is built. Before it was opened to the public, the structure was tested to its full capacity with bags of sand, which were left on the platform for five weeks. At the end of that time it was found that the deflection of the upper landing plate was less than one-tenth of an inch. When the weight was removed, the plate returned immediately to its normal position.

The total height of the structure is about sixty feet.

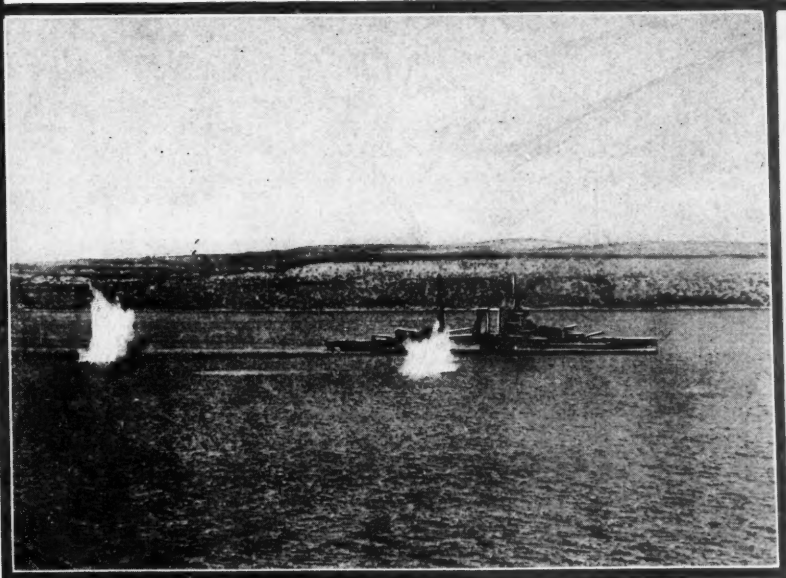
A New Discovery About Shaving Soap

That the lather with which the shaver covers his face is valuable as an antiseptic, apart from its other uses, is asserted by a distinguished English authority.

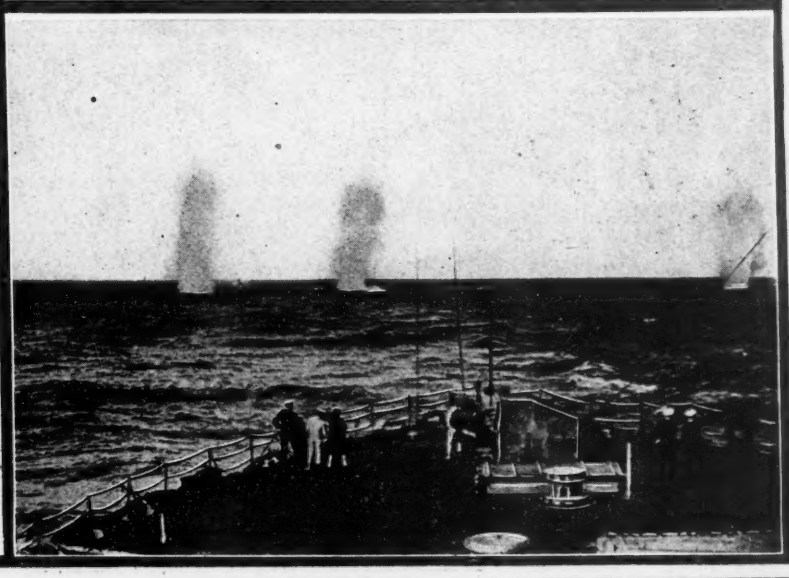
Soaping the face prior to shaving the beard is regarded merely as a means of facilitating a troublesome operation. A razor is really a saw, and shaving is a process of sawing bristles. Soap is said to extract the oily matter from the hair and thus render it brittle, so that the blade of the razor saws through it easily. With sensitive skins, of course, a soap of good quality and preferably free from alkaline excess is desirable. On the other hand, it might be thought that an excess of alkali would prepare chin bristles more readily than a pure soap or superfatted soap. The corrosive effect of alkali, however, leaves no doubt as to the kind of soap that should be used.

Soap probably plays a more important rôle than that of a saponifier of the natural oil of the hair. In spite of the fact that razor users frequently cut themselves, slight wounds generally heal quickly, and the risk of infection thus arising seems to be almost *nil*. In most cases, therefore, it is clear that the razor blade must be bacteriologically clean—that is, free from septic matter. This may be attributed to the fact that it is probably dipped into hot water before use, or else that the soap lather is antiseptic. The latter explanation, it is thought, is the more probable of the two. The amount of soap rubbed on the skin is considerable if the shaving is to be in any degree comfortable, and soap has enough antiseptic power to destroy the typhoid bacillus if only a six per cent. solution is employed.

THE "QUEEN ELIZABETH" AS A TARGET



The splashes are Turkish shells aimed at the "Queen Elizabeth" in the Dardanelles. No wonder the "Queen Elizabeth" had to withdraw. Below: The forward deck of the "Queen Elizabeth." Officers studying the effect of Turkish fire.



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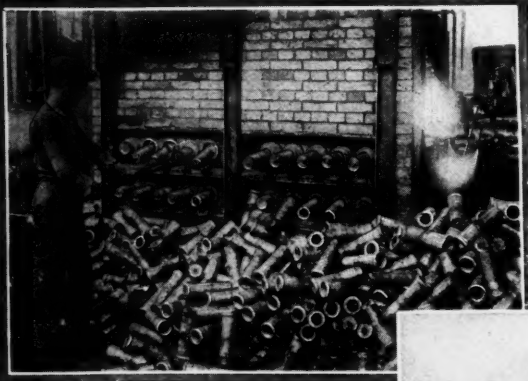
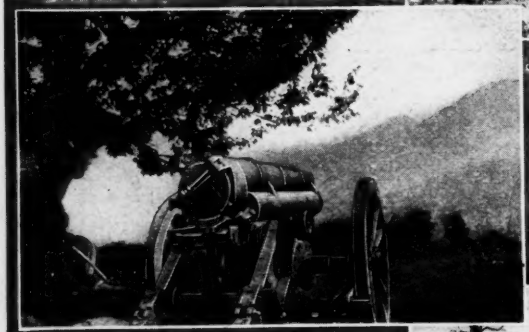
THE TOOLS OF MODERN WARFARE



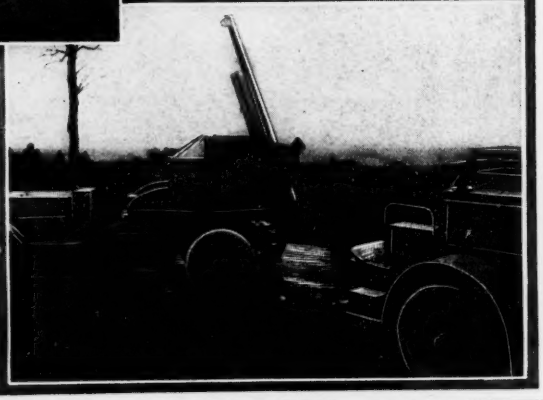
Although it is used only once, a shell is made with the nicest care. It must be hardened, for one thing. Here a French workman is shown extracting shells which have been heat-treated in a gas furnace.

An ordinary French field piece mounted to repel an attack from the sky by German bomb throwers in aeroplanes and airships. When shrapnel is used these field guns are often very effective against air craft.

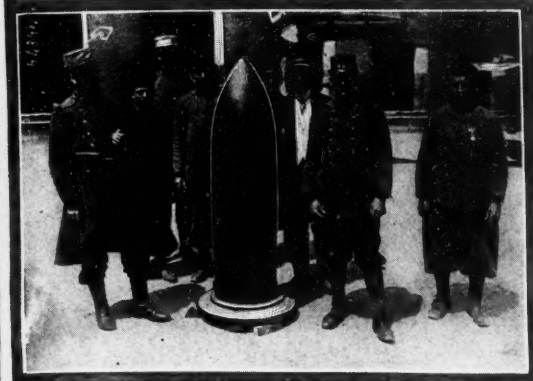


For use in the Vosges Mountains the French have developed an especially light field piece, which can be very easily transported. Forty-two centimeter guns could never be hauled up the Vosges Mountains—one reason why it was necessary for the Germans to go through Belgium.

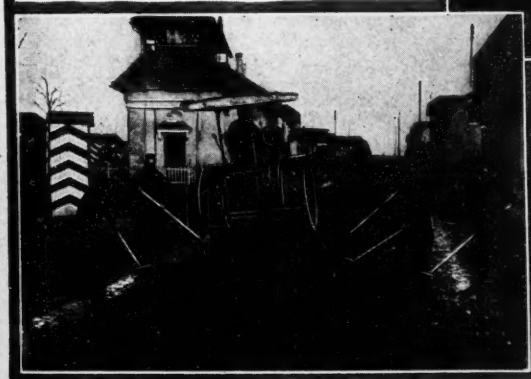
Both France and Germany built armored motor cars with airship-repelling guns upon them, as soon as the Balkan war of 1912-1913 proved that the air scout could gather invaluable strategic information. The guns on the French cars, here shown, have a range of five miles, which is higher than either aeroplanes or airships travel.



INTERESTING GLIMPSES OF THE WAR

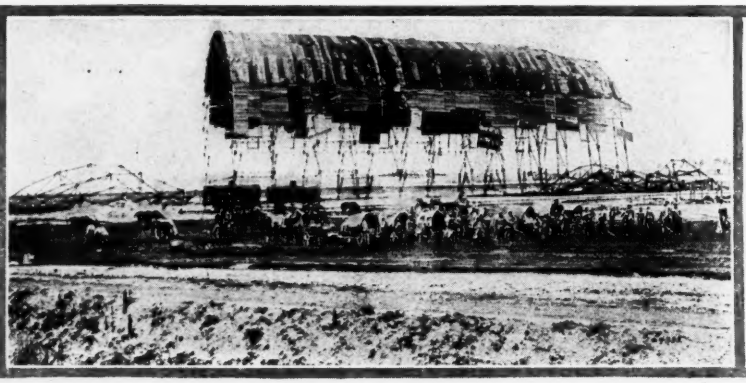


A German 42-centimeter shell which was hurled against a fort at Verdun did not explode. The French picked it up, and now it stands in the court-yard of the famous Hotel des Invalides, Paris, where French veterans live out their days. The projectile stands five feet high and weighs about a ton. In the circle: A German machine gun mounted to repel air scouts and bomb-droppers. To the right: a gun crew hauling an Austrian Skoda gun from its base for transportation.

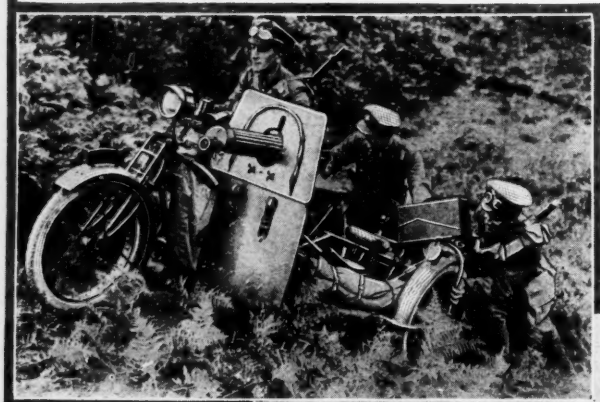


The Germans keep their prisoners busy repairing roads and streets. To the right: A barrel mounted as a field piece to fool inquisitive air scouts. From a height of two thousand feet this looks like a mortar.

THREE PICTURES THAT TELL THEIR STORY

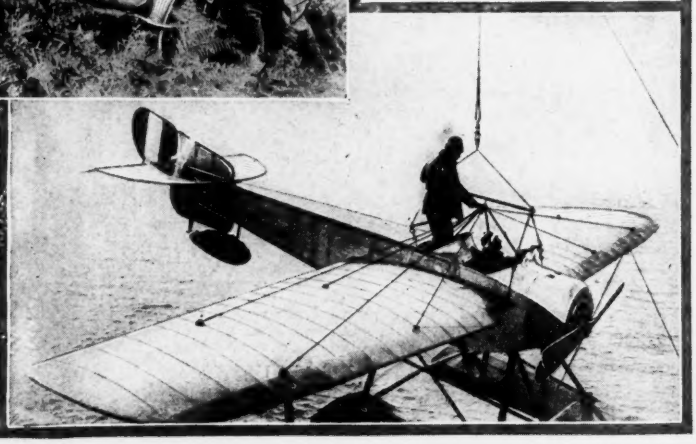


A German Zeppelin shed which was destroyed by a raiding party of British aviators. Not only was the shed blown to pieces but the giant craft within was destroyed. This was, of course, a temporary shed, for the Zeppelins are usually housed in brick structures.



An English machine gun carried on a motor tricycle. Every army is using motor driven vehicles of some kind for the rapid transportation of Maxims.

Lowering a British seaplane into the water. The British have been more successful than any other power with this type of craft.



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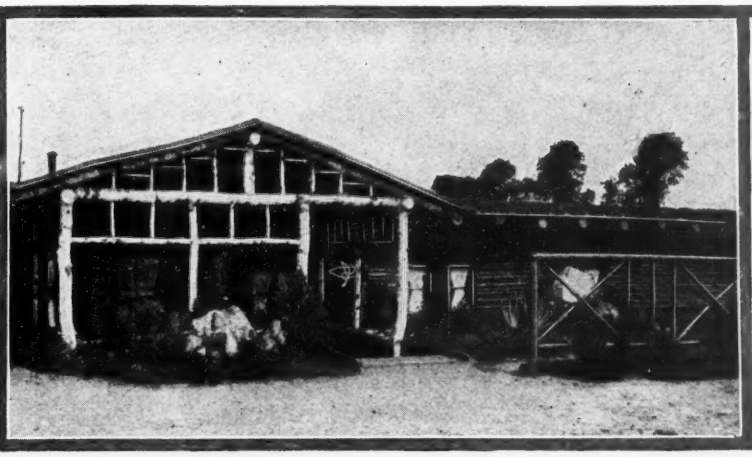
THE GERMAN SIDE OF THE WAR



No, this is not a cosy bungalow for summer use. It is a German officer's dwelling behind the firing line in France. He insists on having white curtains and a garden. Thus he proves what we all know—that on the western frontier ground is won and lost by inches only. This officer may live in his comfortable cottage longer than most New Yorkers live in an apartment. No wonder that we hear of shower baths and running water at the front.

A native village in German southwest Africa. It consists of huts made of poles and skins. The huts are now on British soil, for Germany has lost her South African colonies.

Handing out clean linen on the battlefield to German soldiers. This is part of a hospital division and the linen is intended for wounded lying on unseen cots.

BACK OF THE EASTERN AND WESTERN FIRING LINES

It is not the mouth of a coal mine, as you may suppose, but the entrance to a tunnel dug by French soldiers to reach the German trenches and blow them up.

A French captive balloon about to ascend in order to note the effect of artillery fire on the German lines. This type of vessel was invented by Captain Siegfeld, of the German army, and called by him a "kite balloon." The bulge at the bottom serves to steady the craft in the air, like the tail on a kite.

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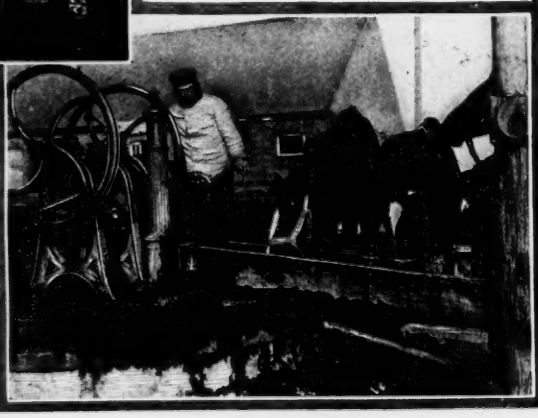
German soldiers bathing in the tubs of a captured laundry. The place was almost made to order for them, with its elaborate hot and cold water plant.

German soldier watering his horses in a captured Russian village. The Germans are as careful of the water which they give their horses to drink as if it were intended for themselves.

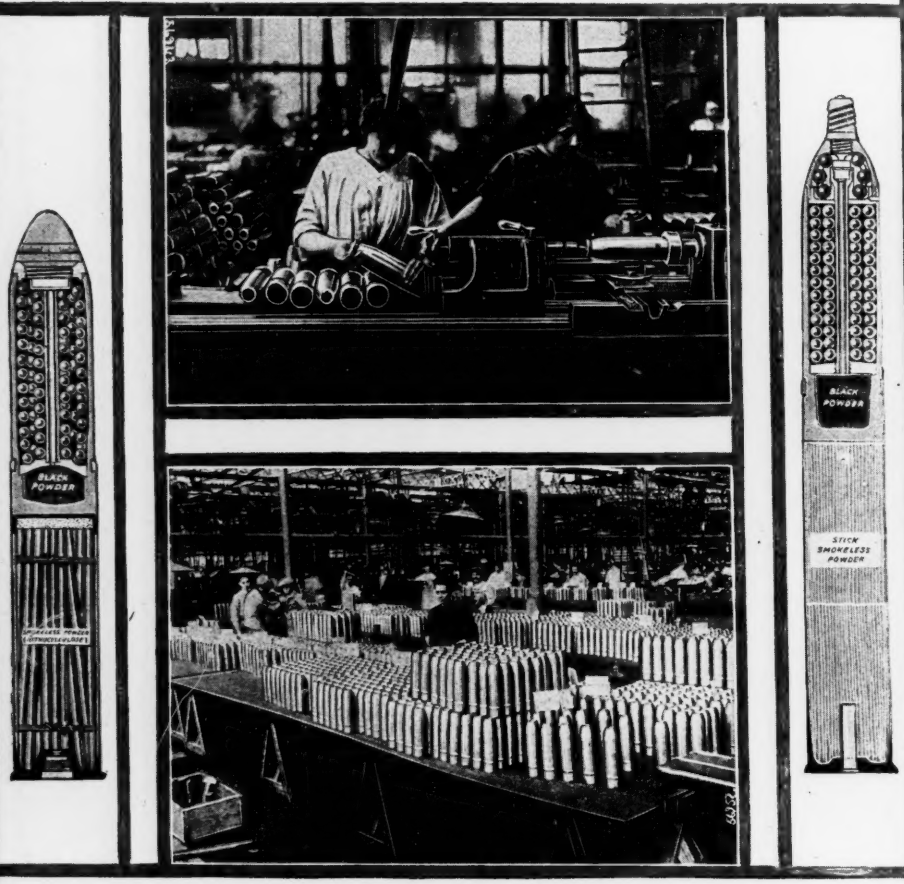


STRANGE PHASES OF WARFARE

Who would suppose that these two men are German soldiers? They form part of a bridge-building company, and their water service uniform is a rubber suit so filled with air that they cannot sink. Paddles are more useful than guns for the work in which they are engaged.

Ask a German to interpret this picture and he will say: "German soldiers reviving comrades who have been overcome by English gas bombs." Ask an Englishman and he will retort: "Germans overcome by their own gas and inhaling oxygen so as to recover and do it again." Which side is right?

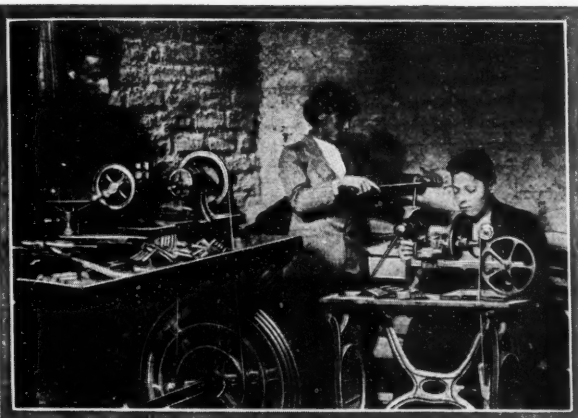
SHOWING HOW SHRAPNEL IS MADE

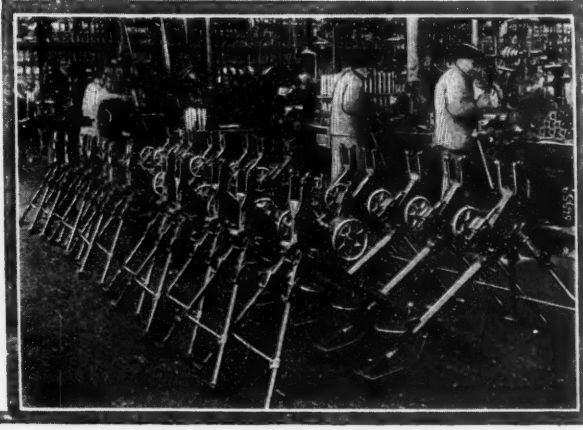


IT is one of the grimmest aspects of war that tender-hearted women should be engaged in making ammunition of the deadliest kind. Since the entire arms-bearing population of France is fighting in the trenches women have been recruited to man the machine-tools, without which it would be impossible to produce the shells fired by the thousand during the course of a battle. In the upper picture a French woman is turning a shell; in the bottom view French women are inspecting shells.

Two forms of shrapnel are here shown—a German three-inch to the left and a French three-inch to the right. Both are drawn to scale. A shrapnel is really a kind of shell hurled by a field piece at the enemy, which carries about three hundred bullets in its head and is so timed by a rather complicated mechanism as to explode above a hostile force and scatter its bullets

IN THE WORKSHOP OF DEATH





over a wide area. Shrapnel is the deadliest form of projectile fired by artillery. The range of shrapnel is about a mile and a quarter, which distance is covered in twenty seconds. It will be noticed that two charges of explosive are contained within a shrapnel shell—one a charge of black powder, the other a charge of smokeless powder. The first is a bursting charge and serves to blow the bullets out of the shell; the second propels the shell from the gun. There is but little difference between the shrapnel shells of the warring powers. To the left on this page appears the type of shell used by the British, while to the right is that used by the Russians. Both are essentially similar to the shells illustrated on the preceding page. In the upper picture Armenians are shown manufacturing munitions of war. The lower picture is the interior of a French factory where machine guns are made.

Upper Photo. Copyrighted, Underwood & Underwood.

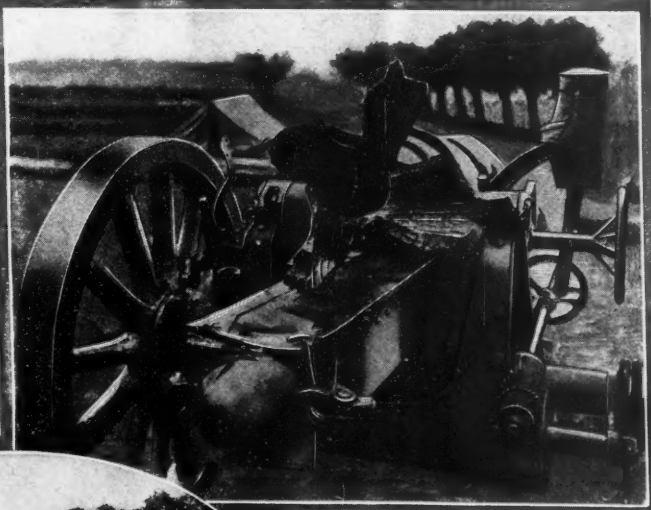
A TORPEDO WITH WINGS

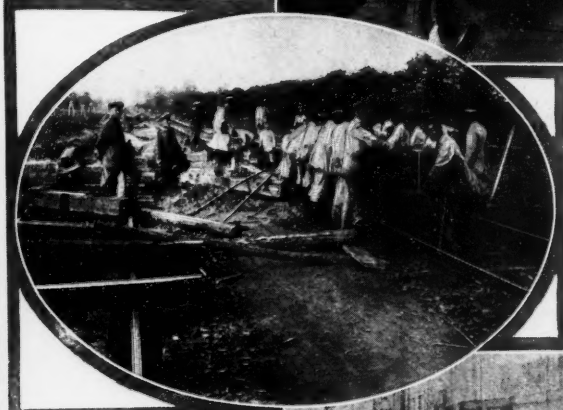
HERE we have a novel type of French trench gun. It fires a torpedo shell which has wings so that it spins and keeps on a straight course. The shell has a rod like a rocket which fits into the barrel of the gun.

Photo Copyrighted International News Service.

CURIOUS ACCIDENTS OF WAR

A Russian field piece which was hit squarely in the muzzle by a German projectile. The mouth of the gun was torn open. The flaring parts of steel clearly show the rifling of the gun.

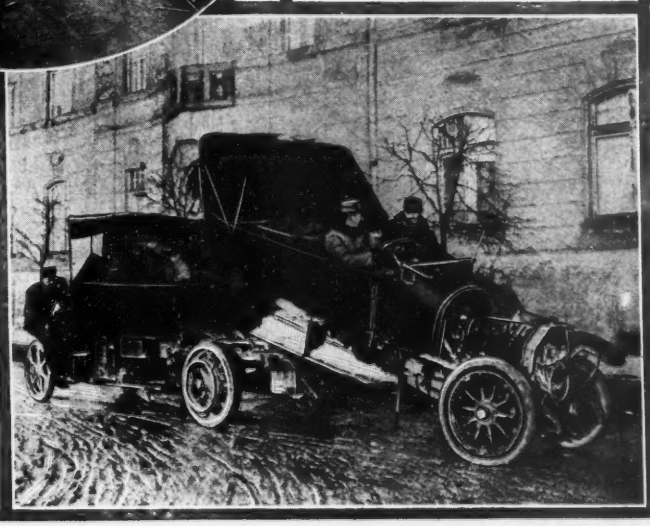




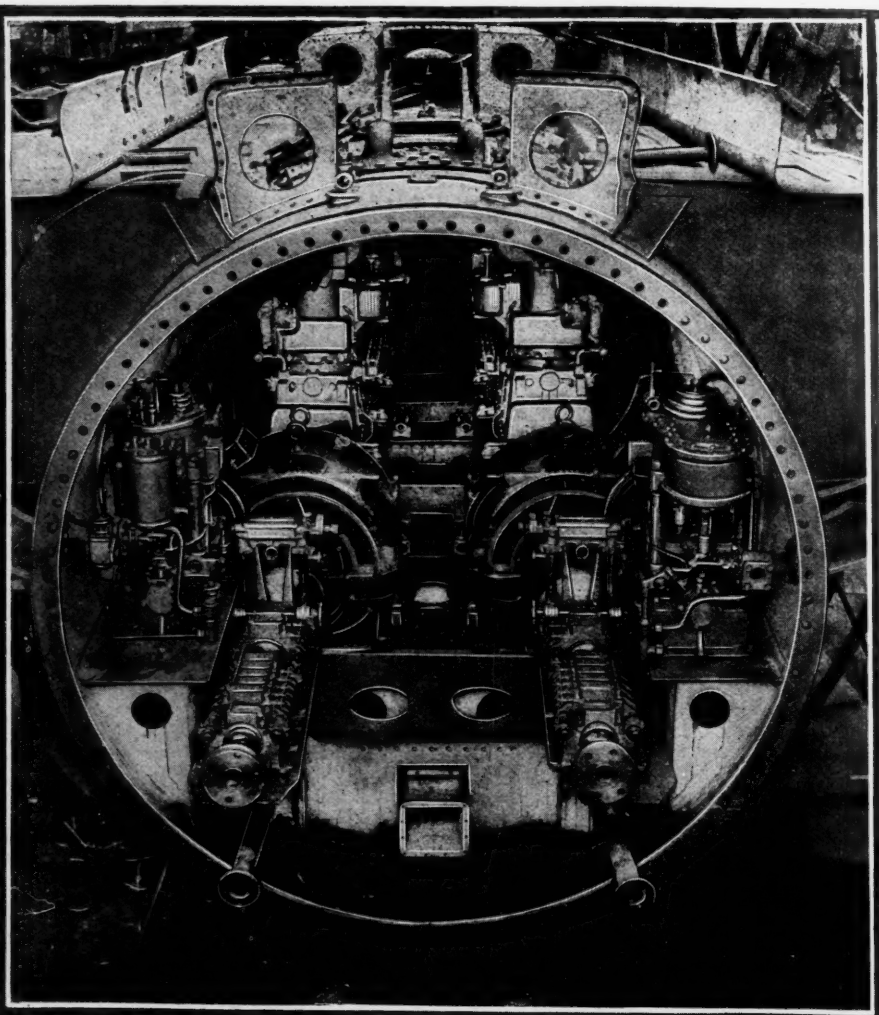
German troops reconstructing a damaged railway which they required for the transportation of supplies in the Poland theatre of war, where good roads are scarce, and railroads even less common.

Photo, Copyrighted, Underwood & Underwood.

This Austrian automobile was crippled so that its rear wheels were useless. To transport it to a repair shop it was partly carried on a motor truck, as shown, with its front wheels on the ground.

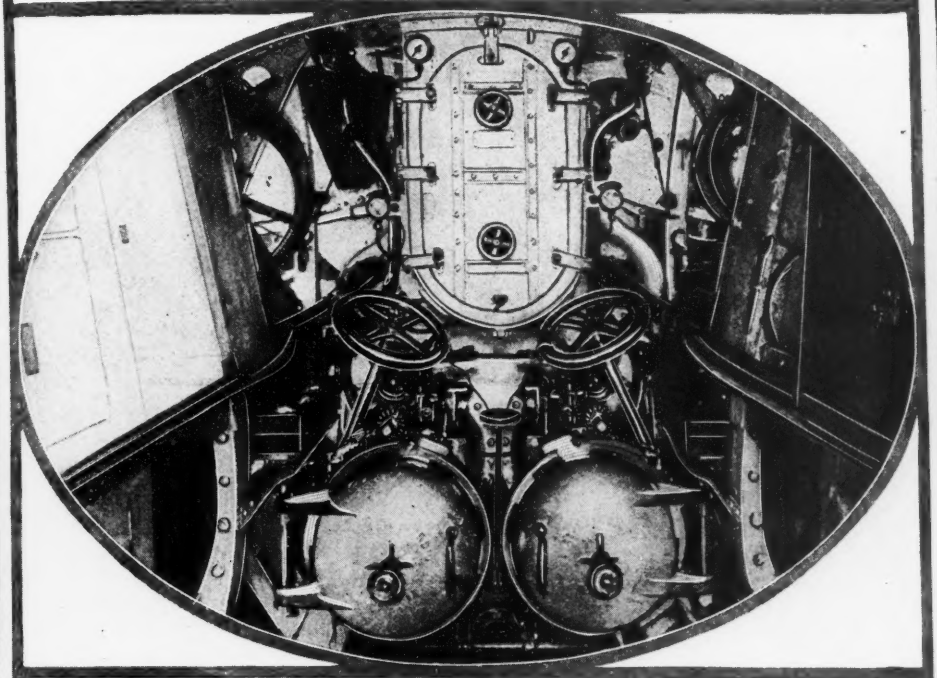


THE VITALS OF A SUBMARINE

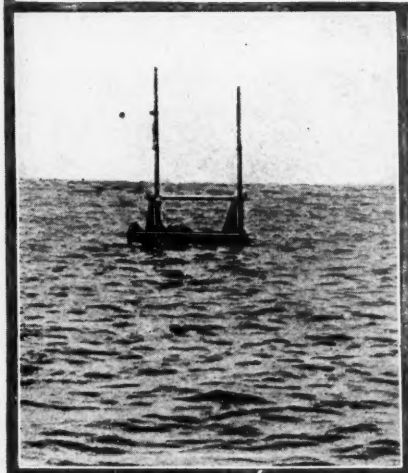


THE interior of a Krupp submarine boat is packed with about as much mechanism as a watch. Diesel engines, dynamos, storage batteries, torpedo discharging tubes, not to mention living quarters for the officers and crew, seem huddled together; yet in reality they are nicely disposed with an eye to making the most of every square inch of space. When submerged, a submarine makes about eight knots; on the surface at full speed, about twelve knots. Before a torpedo is fired the bearings of the ship to be destroyed must be taken by compass. Then the submarine launches a torpedo. Once below the surface, a submarine is blind. There is no way of training the torpedo except by trimming the entire boat.

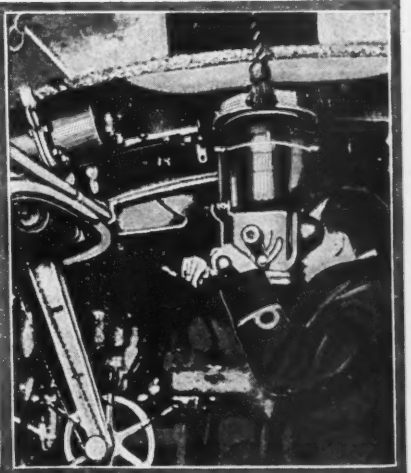
THE BUSINESS END OF A SUBMARINE



The torpedo compartment of an Italian Fiat San Georgio submarine boat of 250 tons. The two torpedo launching tubes are clearly visible in the lower part of the picture. The Italians have done as much as any European power to develop the large submarine boat.



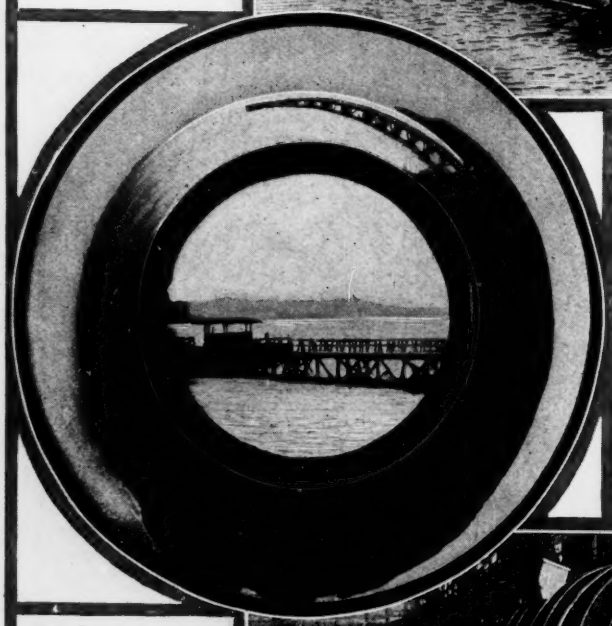
Two periscopes are often found on submarines, so that at least one may be left if the other is shot off.



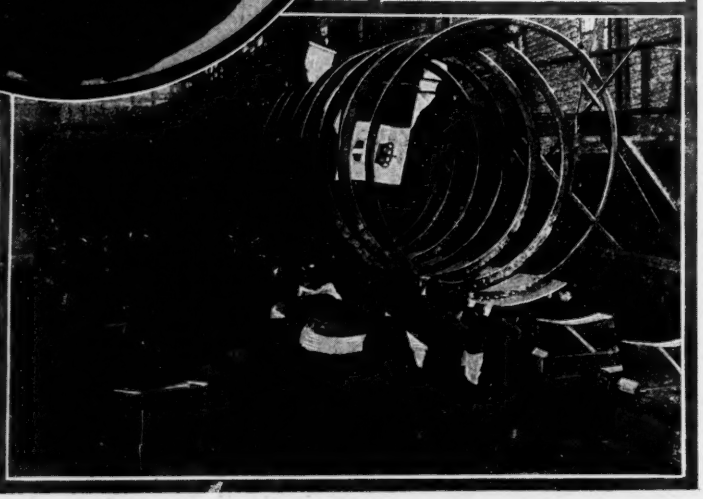
The eyepiece of a periscope as it appears in an Italian submarine boat.

THE UNDERWATER PERIL

An Italian submarine leaving the cylinders of a floating dock. The vessel is tested in the cylinders for water-tightness from time to time.



What the man at the eyepiece end of a periscope sees. He has a clear view of the entire horizon. No ship escapes his eye. Without a periscope a submarine would be sightless. It has therefore been well named "the eye of the submarine."



A submarine boat in course of construction. Circular steel hoops would make it seem as if a huge steel barrel were being built.

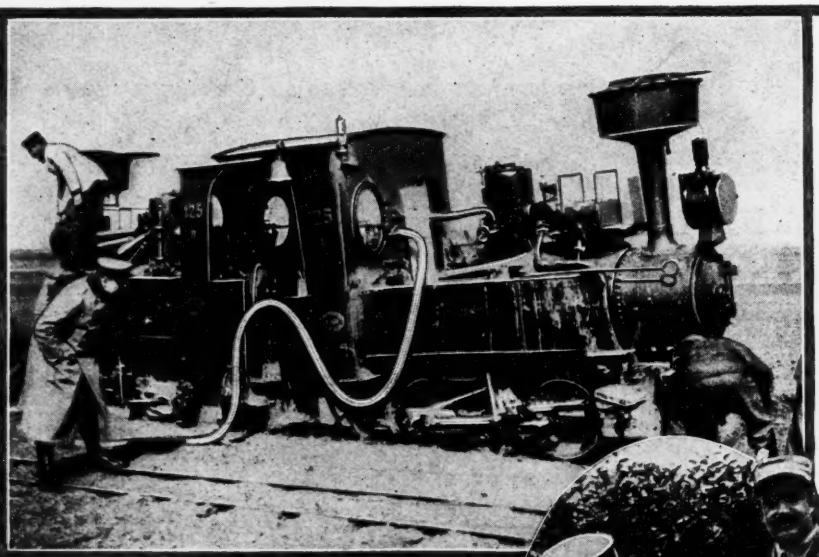
THE GRENADIER IS RESURRECTED

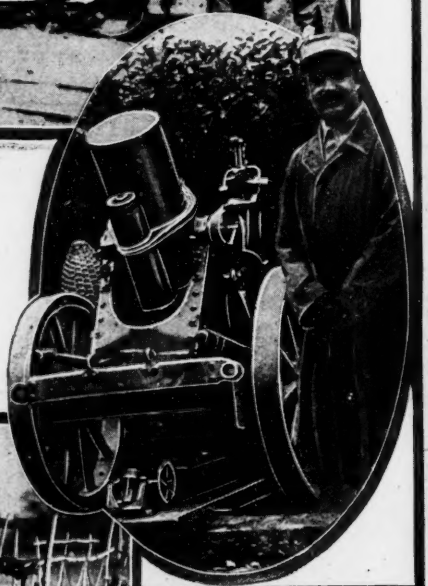
How the war methods of long ago are resorted to in the present war, due to the requirements of trench warfare

MODERN trench fighting has revived the use of weapons which military officers thought had been abandoned for good and all more than a century ago. It is necessary to throw bombs and grenades into the trenches of an enemy. To do that both the Roman catapult and the old-time grenadier have been resurrected. Progress is made backwards in this war. The picture shows grenadiers of modern times—their heads protected by steel helmets against shell splinters, their chests guarded by bullet-proof waistcoats, and their lungs protected by masks which cover their nostrils and mouths. Various forms of grenades are shown in the small pictures, the two top views illustrating a grenade hurled by a rifle and the two lower views hand grenades used respectively by the French and Germans.

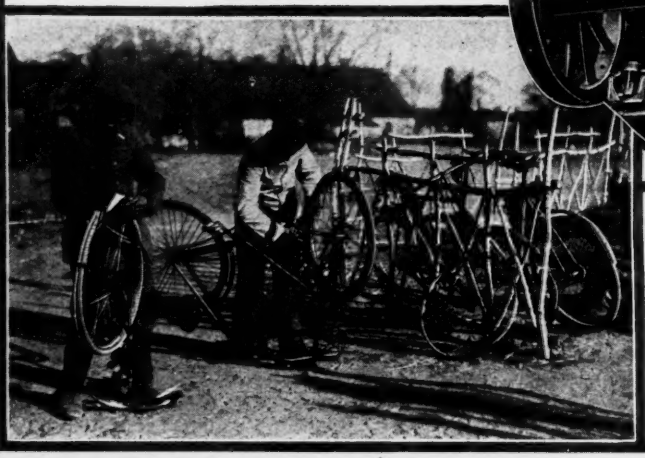
Photos. Copyrighted, Underwood & Underwood

THREE NECESSARY WAR MACHINES





Locomotives are as important as cannon in this war. Were it not for their marvelous system of railways, the Germans would not have succeeded in shifting troops and supplies from one frontier to the other. Here we see a double end locomotive in distress. To the right: An Austrian field howitzer. The short cylinder beneath the gun takes up the recoil.

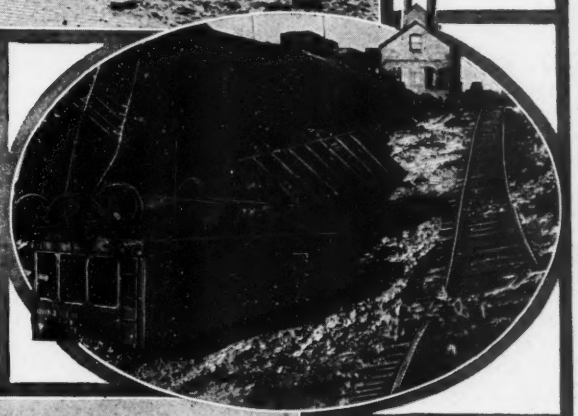


German cyclists repairing their wheels. Most military bicycles are collapsible so that they can be carried on a man's back if need be.

THE AFTERMATH OF A CLOUDBURST

That a heavy downpour of rain is capable of creating havoc comparable to that of an earthquake is proven by these pictures. Here are various views of destruction arising from a cloudburst.

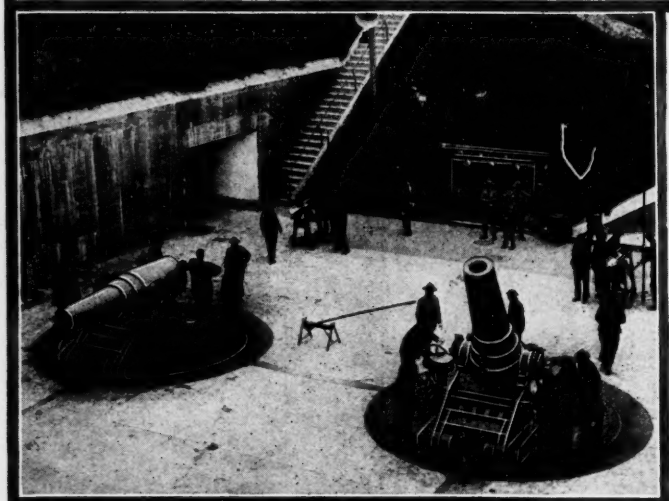
One of the hundreds of houses that were wrecked in the city of Erie, Pa., during a recent cloudburst. Owing to the disorganized police protection, the State militia was placed on guard.



Railroad embankment that was washed out by the onrush of water following the cloudburst. At the left: Searching parties at work among the debris, clearing the wreckage and hunting for bodies.

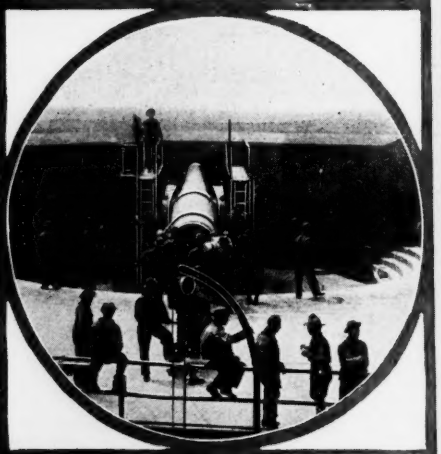
Photos. Copyrighted, Underwood & Underwood

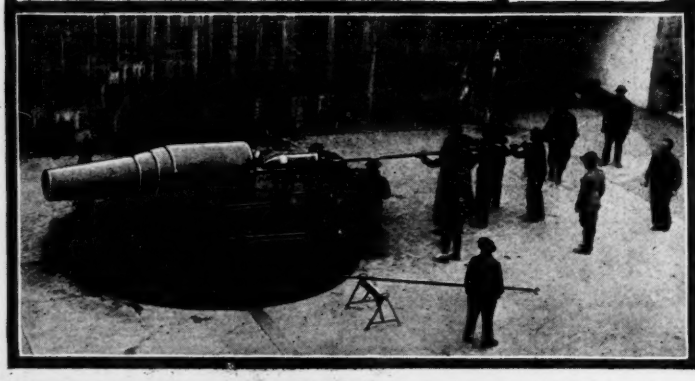
OUR COAST DEFENSES ARE IMPRESSIVE



Mortar batteries are sunk in concrete pits. The men who fire the guns never see where the shots fall. The mortars are trained in response to telephone directions given by the men at the range finders. The Eighth coast defense command of the New York State National Guard is here shown drilling with 12-inch mortars at Fort Wright on Fisher's Island.

According to Captain Charles E. Kilburne, of the General Staff of our Army, our twelve-inch coast defense guns seem more terrible than they really are. Their extreme range is fifteen thousand yards, but a German or an English fleet from the safe vantage point of twenty thousand yards could disable them easily with the aid of aeroplanes to direct the fire. The trouble is that the coast defense gun can be elevated only fifteen degrees, whereas foregn war vessels can elevate their guns anywhere from fifteen to thirty degrees and thus throw their shells farther. If our coast defense guns could be mounted so as to permit their elevation to a maximum of forty-five degrees, a range of 33,000 yards would be possible. The officers of the Coast Artillery are now trying to work out a plan of modifying the carriage mechanism so that greater elevations are possible



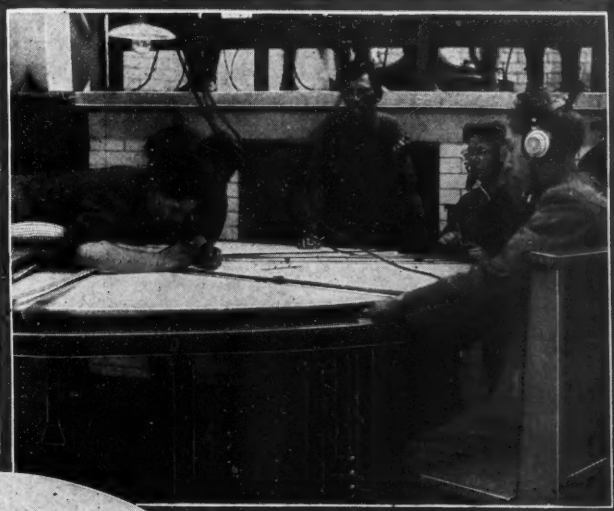


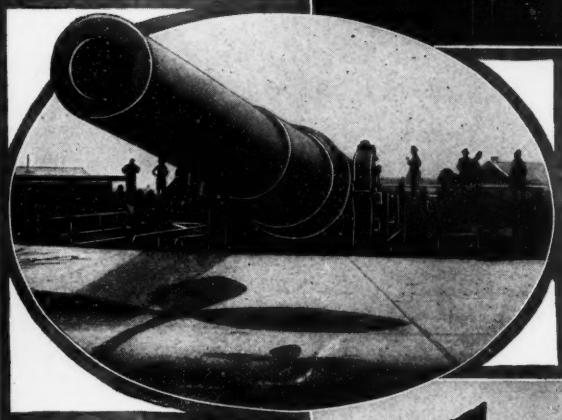
Loading a twelve-inch mortar. The shell is brought to the piece on a little wagon and driven into the breech of the gun with a ramrod. Our mortars are about as good as the best made by Krupp

Photos Copyright, Underwood & Underwood

BUT NOT AS FORMIDABLE AS THEY SEEM

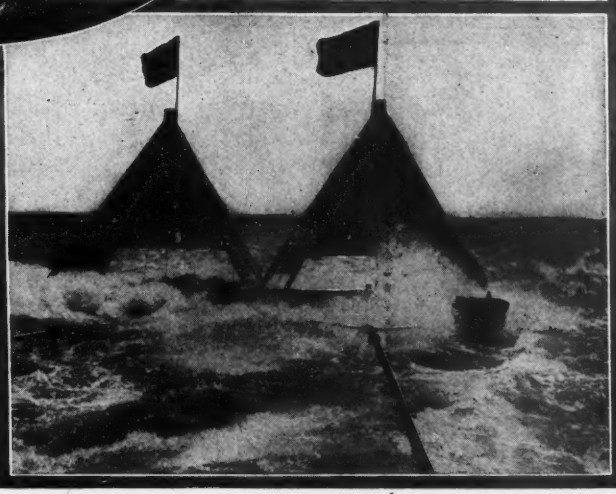
The chart room at Fort Wright, where the exact positions of the targets are located. Once a ship comes within range of the guns it is almost sure to be hit. Its position is determined exactly by a simple system of triangulation and telephoned to the gunners.





The muzzle of a twelve-inch coast defense gun. It is mounted on a disappearing carriage. The recoil of the gun drives it back on its carriage below the parapet. Disappearing carriages were invented by Colonel Buffington and General Crozier of our army. No other power has adopted them.

The targets which are used to train the crews of our coast defense guns. They are simple canvas pyramids carried on a raft and towed at a safe distance by tugboats, at moderate speed.

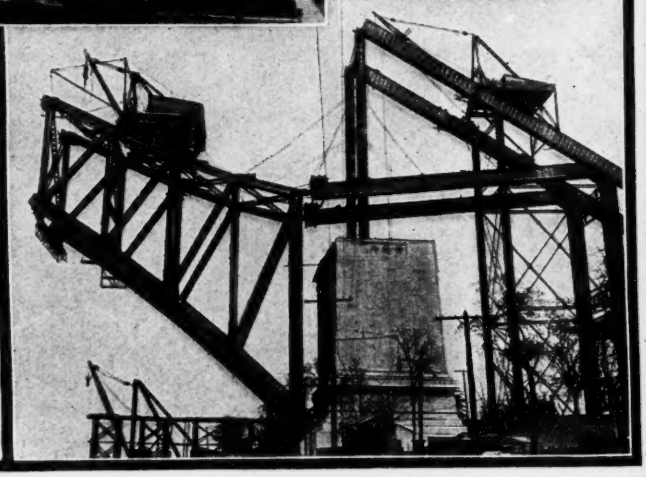


Photos. Copyrighted, Underwood & Underwood

A GIANT BRIDGE OF STEEL AND CONCRETE

View of the anchorage at the back of the span which will form part of the giant steel arch bridge over that part of the East River known as Hell Gate, New York City. The anchorage is of steel and will later form part of the approach to the bridge.

The line of concrete arches that will carry the approach to the main span. There are 120 of these arches, the tallest one being 124 feet high.

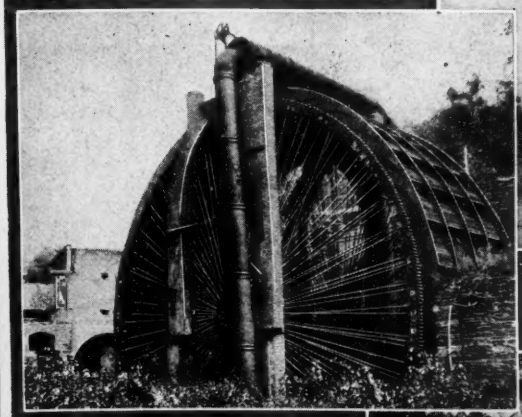


This view shows part of the huge arch under construction. The bridge, when completed, will be the heaviest and longest single span steel arch bridge in the world. 80,000 tons of steel will go into the arch. It will be 1,000 feet between abutments and will carry four railroad tracks.

THE CURIOSITY SHOP OF THE WORLD

At the right: The only winding stairway in the United States that is made entirely of concrete is located at Glens Falls, New York. It has fifty steps and makes two complete turns.

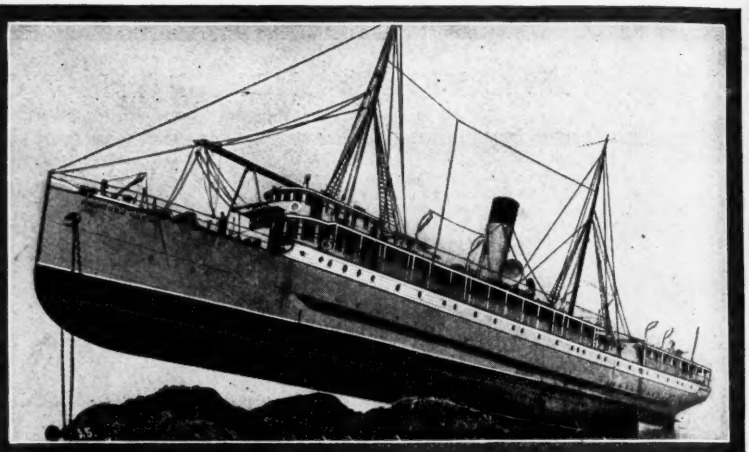
Above: What happened when an automobile struck a deer. The deer was instantly killed; the car turned turtle, caught on fire and was entirely destroyed.

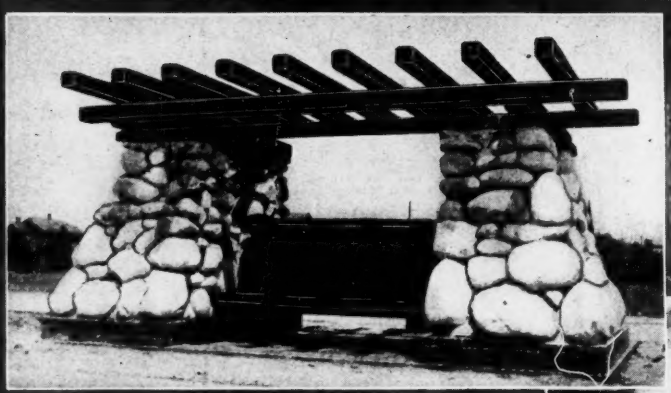


Built in 1838, this water wheel was in continuous service until 1890, at Troy, New York.

All that remains of the hull of "The Revenge," one of Benedict Arnold's fleet which was defeated by the English at Valcour Island on October 11th, 1776. She carried eight guns. The old hull was recently raised out of Lake Champlain and placed on exhibition on the grounds of Fort Ticonderoga, N. Y.

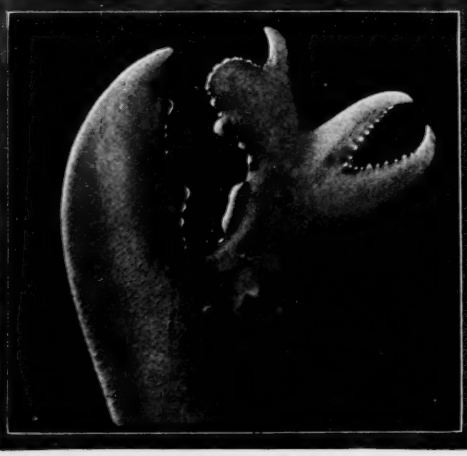
The wreck of the steamer "Princess May" on Sentinel Island, Alaska, was perhaps the most remarkable ever seen on the Pacific Coast. The vessel ran on the reef at high tide. At low tide two-thirds of the hull was in mid-air. At the next high tide the ship was floated, with practically no damage.

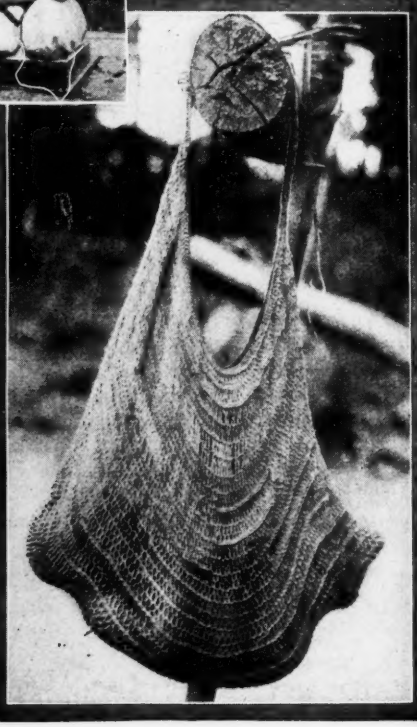




A rest station built of heavy cobblestones and Portland cement. This rustic work is costly; in this instance the sum of $400 was expended. Some of the boulders weighed 1,500 pounds.

Below: The double claw of a lobster captured at New Bedford, Massachusetts. The extra claw, however, is of no value to its possessor, since it is fixed. At the right: A bag used by a Papuan for holding her child.





How Movie Men Film Royalties

By Ernest A. Dench

THE filming of royalties presents probably the most difficult task a moving picture camera man can possibly encounter. Kings and queens are zealously guarded, and access to them is had only by long and tedious waiting, if at all. The authorities must be extremely careful, as the trick has already been tried by terrorists of disguising an anarchist as a movie operator. Fraudulent credentials have been used repeatedly.

In England, when a royal procession is held, the route they intend traversing is circulated beforehand. This affords the photographers an opportunity of selecting an advantageous position. Exciting competition for best places results. Operators as a result often seize an advantageous viewpoint and maintain possession by remaining for a night and until the procession passes.

One time, when King George and Queen Mary attended the horse races, the rumor was circulated that the militant suffragists would make an attack on the royal automobile, so steps were taken to prevent every suspicious character from approaching. The police even forbade movie photographers being present. However, the rumor reached the ears of King George, who is an ardent movie fan, and he issued a statement which has become an epic in moviedom.

"Only a few thousands of the millions of my countrymen throughout the world can see the part I play in this event," he said, "but a motion picture can convey it to all my loyal subjects whether they reside in London or Australia."

In Germany, the difficulties are even greater. The operators are asked the most searching questions by the authorities and have to make the best they can of the position, which is seldom satisfactory, allotted to them. They are also required to promise not to export the film without submitting it to be deleted of any military information of any value to an enemy power. At all events, these rules were in force before the war, and in all probability they have since been made severe to a point almost beyond conjecture.

The moving picture as a result of which these stringent rules were made depicted the entry of Emperor William's daughter and fiance into Berlin. This was exhibited at the Berlin theatoriums on the same evening. The police intervened, and all of the copies in circulation were confiscated.

Russia has long been recognized as the home of the iron hand even in times of peace. The Czar values his privacy highly; at least moving picture men find it the height of impossibility to gain an interview with him.

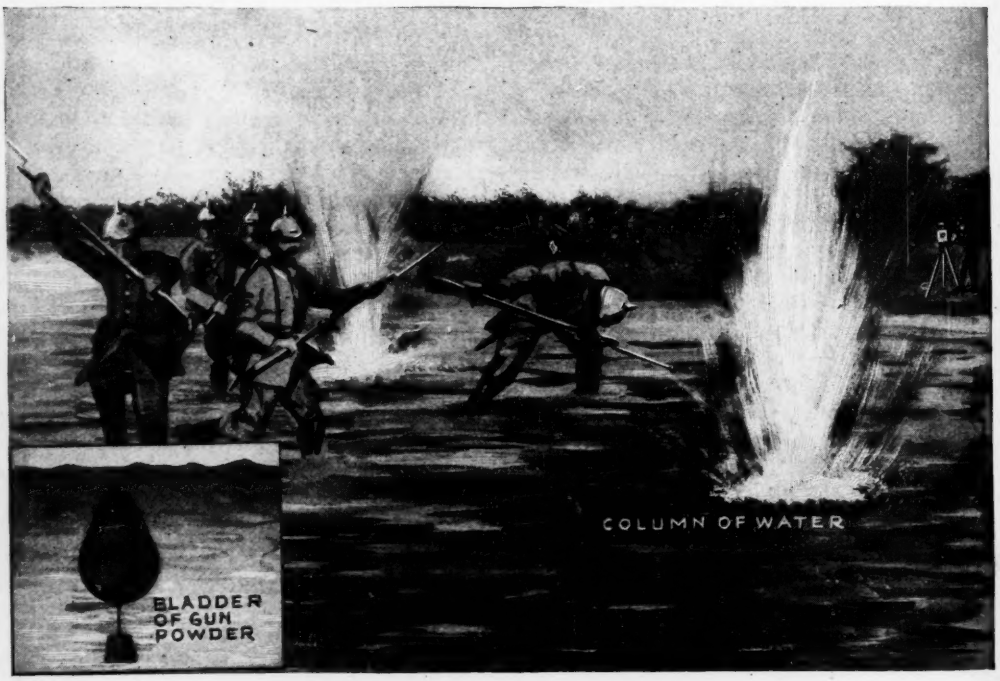
Although the moving picture photographers are more greatly restricted now than in the past, one time, during the reign of Alexander III, a dauntless operator succeeded in filming the imperial family at three yards' distance, something that has never before been accomplished during a Russian official ceremony.

However, this daring feat was accomplished in the pioneer days of cinematography.

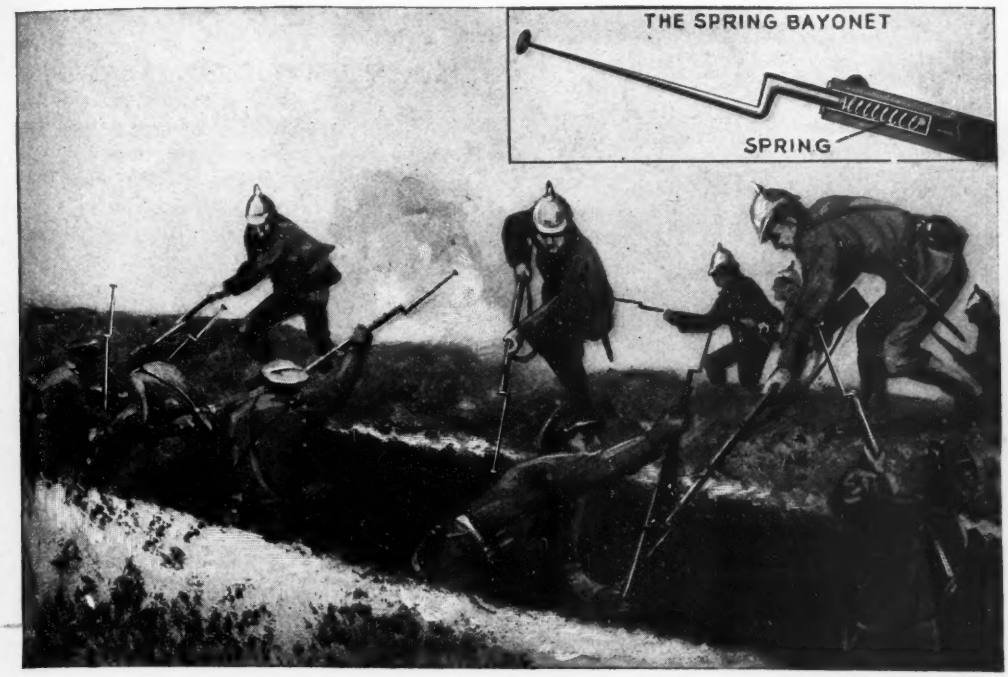
HOW FAKE WAR MOTION PICTURES ARE MADE

WAR pictures, so we are told by a London correspondent, are even more popular in Great Britain than here in America, and the English people are now reveling in vivid war dramas which are faked on the hillside and the rolling downs of the south coast. Clever mechanical devices, the unstinted use of electricity, spring bayonets, gunpowder bladders and underground explosives are used in the production of grim war pictures, realistic to a degree and bearing the earmarks of the French and Belgian trench and the Polish battlefield.

Agricultural laborers, farmers' sons and village youths, dressed in the uniforms of the British and German armies, are drilled in their new duties and initiated into the mysteries of disappearing bayonets, exploding fake shells, trench warfare and make-believe "gassing." Stroll along a quiet, country footpath bordering some rolling grassland sloping to the sea and you may come upon a horde of yelling men whose spiked helmets and wicked-looking bayonets glint in the sunshine as they charge toward you. If you take cover nimbly and



On the screen the German soldiers are seen crossing a stream with the enemy shells falling dangerously close to them. In reality, the columns of water are caused by bladders filled with gun powder, which are concealed below the surface of the water and electrically exploded at the desired moment.

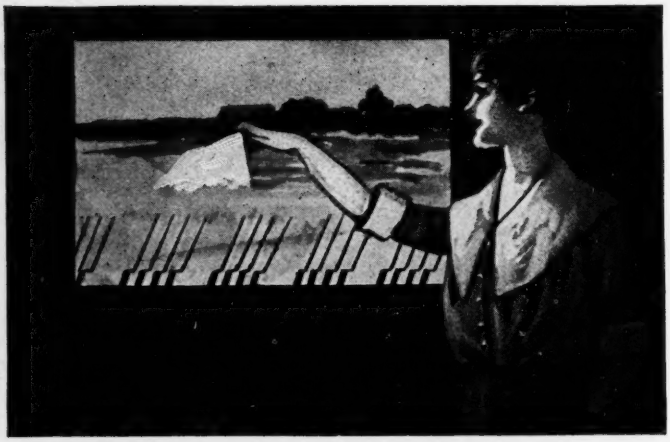


To the audience the scene is one of a most desperate nature, with the German and English infantrymen engaged in a life-and-death, hand-to-hand bayonet encounter. But the scene loses much of its thrill when it is explained that the bayonets are provided with safety tips and slide against a spring in a tube, when pressed.

watch you will see they are rushing a trench filled with khaki-clad British soldiers. You shudder involuntarily as you see those glinting bayonets sinking into human flesh three or four inches, but you find later that the points are protected with little felt buttons and that they are attached to the barrel end of the rifle by a spring that allows them to retract several inches upon striking a solid substance.

As the soldiers ford a stream in their mad charge, columns of water splash high into the air. After awhile you realize that these columns are caused by dropping shells from concealed artillery. You wonder how it is that all these country "supers" are not maimed or even killed until you find out that the water columns are caused by electrically-exploded bladders filled with gunpowder and hidden beneath the surface of the stream. As the charging "Germans" reach the opposite bank and make straight for the "British" machine guns, terrible explosions occur. They are the shells still "dropping" from the British artillery. The explosions are electrically controlled by a stage director or producer, and are caused by burying small cans of gunpowder here and there under the ground to be rushed. At the proper moment the fake mines are exploded by throwing a switch or pressing a button, thus sending clods of earth, a cloud of smoke and a dummy figure or two into the air. All the vivid effects of a big shell bursting on the ground are thus obtained.

To give to the moving picture patron an idea of the vast numbers of troops now in France, the producers used an ingenious leather band machine, which, in conjunction with a broad window built into the scenery wall, is all that is necessary. The spectators in the theater see women at the window waving out to the departing troops. The tops of rifles with bayonets fixed move past the window and bob up and down in a never-ending stream. Beneath the window, concealed from the spectators, an oper-



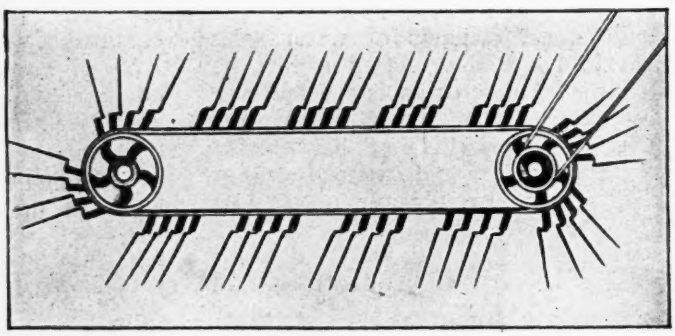
What a large cast the company must have employed to produce this picture showing troops passing by the window! But look at the next picture.

ator turns a leather band passing over two fly-wheels about twelve feet apart. Attached to the top of the band are rows of bayonets. As the handle is turned the bayonets move along with the realism of a marching regiment, rifles on shoulders, fastened, as they are, to the leather band which can be moved at any speed.

In "close-up" pictures of big explosions, such as bridges, forts and the like, it is not politic for the movie men to get too close; a chance projectile may come their way. To overcome this difficulty the camera is set up in some adjacent spot and focused upon the scene of the explosion. From a safe distance the operator controls his camera by electrical wires, the result being as satisfactory as if he had been on the brink of the scene himself. So excellent are the pictures of modern "warefare" thus obtained by producers in rural Britain, that the motion picture theatre patrons cannot realize that motion picture men are not allowed near the firing line in the theatres of war and that the restrictions imposed on the producers prevent them from obtaining the real thing in France.

Motion Pictures Aid in Teaching Students of Agriculture

The Agricultural College of North Dakota is making extensive use of motion pictures in the lecture course which is given by the college. Mr. A. P. Hollis, the lecturer, has traveled in the past two years with a motion picture machine and an unusually complete set of reels. Some of the films serve to draw young men and women to the college, showing the general activities of the campus, views of the buildings, and the various phases of outdoor construction. Other reels are educational, showing improved methods of farm cultivation, the detection and prevention of disease to animals and to crops, and other subjects tending to inspire the farmer to greater efforts in efficient farming.



A continuous belt mounted between pulleys and provided with bayonet-like projections furnishes the "army" that is passing by in the above view.

The Secret of the Animated Cartoon

By Eustace L. Adams

WE have been watching a famous "Animated Weekly" for fifteen minutes. We have seen pictures of fires, of disasters entailing the loss of hundreds, even thousands of lives, and of the cruel and heartless World War, until our spirits are at their lowest ebb. Before our eyes French and Belgian villages are wiped out by the struggles of nations, and ambulances carrying maimed bodies flit past, until we feel that the world is all awry.

Suddenly the pictures change. Our old friend, Col. "Heeza Liar," appears and, after a few minutes of ridiculous and absurd gamboling, the world is set right again, and our spirits soar to par.

How is it done? Whose is the skillful hand that can produce this animated cartoon, most popular of screen comedies? Remember that a motion picture film consists of thousands of scenes which are flashed on the screen at the rate of sixteen a second—so rapidly that the eye cannot perceive the interval, with the result that the sensation of continuous motion is produced. Who has the patience to draw thousands upon thousands of pictures which are all thrown upon the screen in so short a time.

Bray has made a thorough study of the producing of animated cartoons in motion pictures and his name is known to the hundreds of thousands who go to the movies.

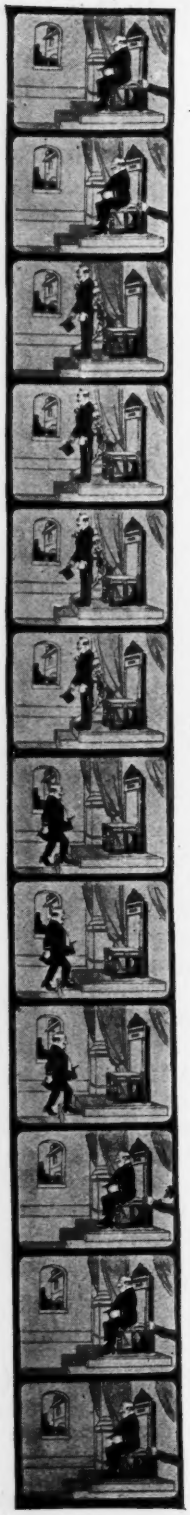
Seated in his little private office in a great building near Madison Square, and surrounded by volume upon volume on zoölogy, sits J. R. Bray, one of the most famous of motion picture cartoonists. From struggling newspaper artist to head of a syndicate supplying the ever-increasing demand for animated cartoons is the tabloid history of his career.

At the present time Mr. Bray has a staff of six cartoonists, twenty assistant artists and four cameramen constantly at work preparing 1,000 feet of animated cartoons every week. An idea of the amount of work entailed may be gained from the knowledge that there are thirty-four different processes to be undergone by each cartoon, and that there are from three thousand to four thousand cartoons in each thousand feet of completed film. Hence a week's output involves from 102,000 to 136,000 processes.

The accomplishment of this tremendous task is made possible only by a special method which Mr. Bray has invented and patented. As a result of Mr. Bray's invention the work of preparing thousands of pictures is cut in half. When he has decided upon the desired scene for the antics of "Heeza Liar," Mr. Bray first makes a background on a sheet of heavy paper, which background is then printed on many sheets of tracing paper. This done, it is necessary for the artist only to draw the parts which are to appear in motion on the screen. The result is evident. The background remains absolutely stationary throughout the scene, so that the work of the artist is reduced to a minimum. If a man is to be represented as standing still for any length of time, he is printed on the sheets. He does not have to be drawn again until he is supposed to move.

This permanent background may be easily erased or drawn over. What is more, a large number of copies are printed with portions of the background omitted. This obviates the necessity of erasing to a great extent.

In order that movements may be both steady and continuous on the screen, great care must be taken in the drawing

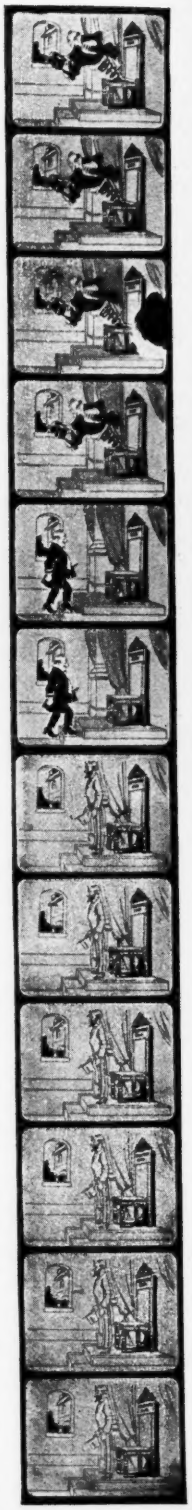


of the cartoons, a task greatly simplified by Mr. Bray's use of tracing paper. The artist merely places a piece of paper upon the last drawing, so that the position last taken by the figures shows clearly through the paper. Thus he is able to draw in the next position carefully and easily.

Mr. Bray supervises personally every stage of the work. He originates the plot and makes from six to a dozen sketches of the vital points of the story. Then the real work commences. While the cartoonists do most of the sketching, Mr. Bray draws practically every movement. If a man, for instance, who has been motionless for some time, is required to raise his arm, the staff cartoonists draw the figure, but Mr. Bray draws the arm in the act of moving. When the sketches have been made, they are turned over to the staff of assistant artists who complete them, drawing them in ink and filling in the color.

To reduce the effect caused by the projection of much white light on the screen, Mr. Bray has invented and patented a process for making a uniform background. By this method one painting of the background suffices for the entire reel.

When the set of cartoons is completed four expert cameramen photograph them to obtain the negative film. An important feature of Mr. Bray's invention consists of a method for controlling the speed of action in the picture. This is done by varying the number of photographs taken of each cartoon. For instance, if the scene demands that an object shall move rapidly, then slowly, and finally come to a stop for a moment, the pictures representing the quick action would each be given one exposure. As the movement of the object diminishes in rapidity, each picture is given a correspondingly increasing number of exposures. When the action comes to a stop numerous photographs are taken of the same picture, the number being dependent upon the length of time that the action is suspended.

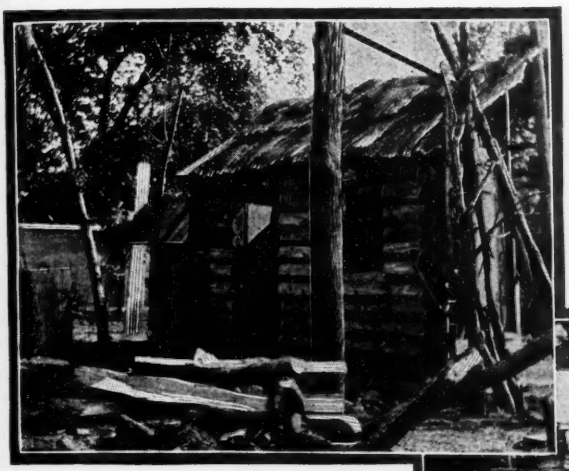


Two strips of typical animated cartoons produced by J. R. Bray.

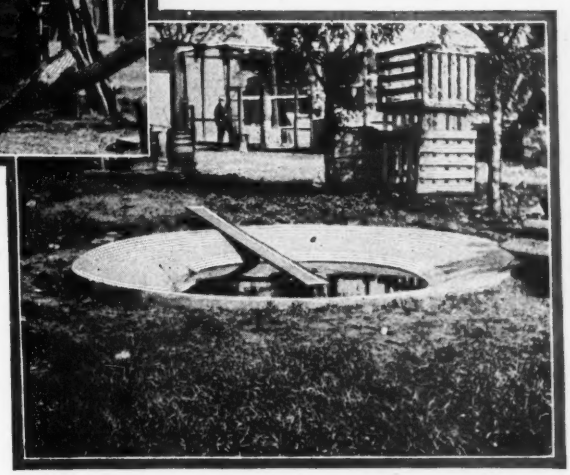
Behind the Scenes of a Motion Picture Play

By Loring Brent

ONE of the greatest differences which exist between the speaking stage and the motion picture studio is the matter of temperament. The stage will always be characterized—as it has been characterized throughout its traditional past—by temperament. The motion picture studio, because of the factory ideal toward which it is tending, may not be temperamental. Thus, at the Essanay studios, where I saw the filming of "The White Sister," featuring Viola Allen, factory schedules and factory rules are enforced. The hours are from 9 a. m. to 5 p. m., with time out for lunch. There is even a time-clock to prevent the temperament from side-stepping.



Below: The "lake" in back of one of the leading motion picture studios is barely twelve feet in diameter. Yet on occasions it serves for scenes representing large lakes or rivers!



Above: A log cabin erected for a motion picture play. While in the film shown to the audiences the cabin appears as a complete dwelling, it is in fact but a front only.

"The White Sister" is a long feature film, probably six or eight reels, and it has required many special sets. The work in progress on the morning of which I write, illustrated an interesting phase in the making of long feature plays, or plays of any length, for that matter—the filming of "flashes." A "flash" is a very short scene which is thrown on the screen for a few seconds to indicate usually the development of a minor plot. It may show, for example, the neglected wife of an absorbed business man enjoying herself at a cabaret, while the main theme of the play—her husband in some financial venture—occupies the long scenes. The brevity of flashes indicates their relative unimportance. Nevertheless, the production cost of flashes is often greater than that of longer and more important parts.

The scenes which traced the major theme of "The White Sister" had been completed; the flashes alone remained. One of these, a private room in a hos-

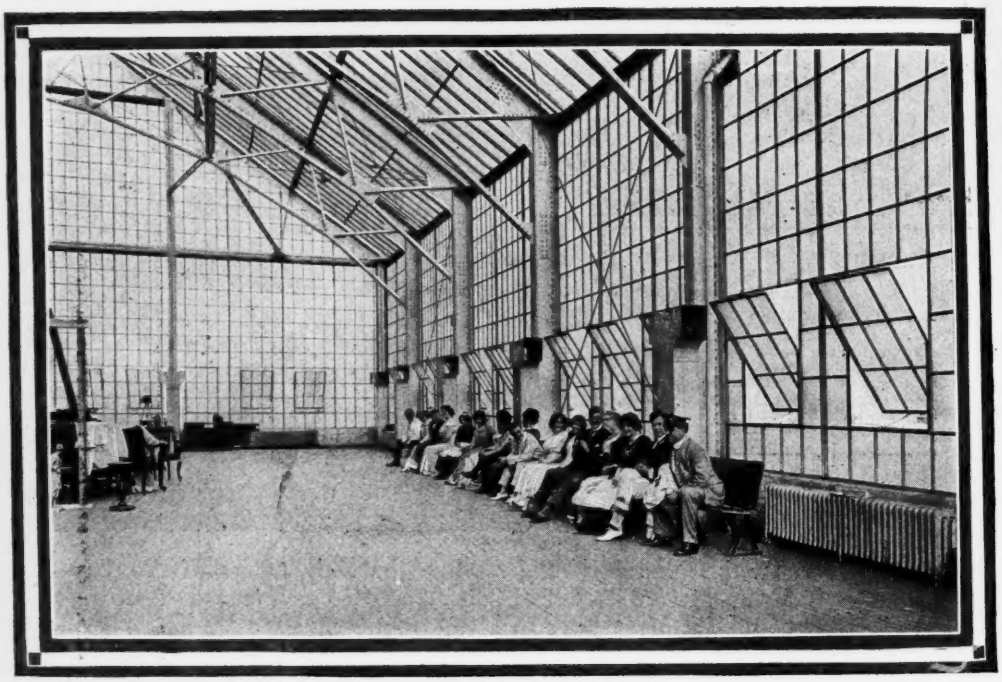
pital, was being filmed. Six times at least Miss Allen, at high dramatic pitch, went through the rehearsal before the camera crank was turned. Although the flash would consume at the most thirty seconds on the screen, the time required for perfecting it amounted to at least three or four hours.

Trolleys For Lighting

"The White Sister" was produced in one of the largest artificially lighted studios in America. The method of lighting is as interesting as it is efficient. Long rows of mercury-vapor arc lamps are suspended from the ceiling on trolleys, so that their light can be thrown upon a scene by merely pulling long cords which run over pulleys and down the side walls. The lights receive electric current through trolley wheels from copper trolley wires above them, just as a street car derives its energy from the wire overhead.

All scenes are illuminated by the greenish light from the long glass tubes. The faces of the leading characters are intensified, and attention thus drawn to them by the concentrated rays of flaming arc lamps. Precautions are taken that a player does not face these lamps any longer than is absolutely necessary; they are almost blinding in brilliancy. Once an actor was compelled to stare for a certain dramatic effect directly across a set of these lights into the face of the "villain." He stared too long, and lost the use of his eyes for several days.

Not every type of actor is fitted for the "movies." A girl may be pretty, a man handsome, yet their features may be of a type utterly unfitted for camera drama. A long or a broad face becomes grotesquely exaggerated. The eyes may be too dull—effective "movie" eyes are usually large and brilliant. Then, too,, the complexion is vitally important. Excessive pallor is grewsomely intensified when it is filmed. High color in patches on the skin appears a deathly black on the screen—and often no amount of paint and powder will conceal the defect; mercury light seems to penetrate directly



The daylight studio of any motion picture producer is an imposing structure from the viewpoint of the layman. It is usually a steel framework covered by thousands of panes of glass.

to the surface of the flesh. Another interesting fact is that some faces "photograph better," as directors say, than others. Some are clearly defined; others are blurred and hazy. No one knows why.

The "back yard" of a motion picture studio contains the most diversified collection of dwellings, vehicles, structures and geographical features imaginable. In fair weather most of the scenes, whether they are "Interior" or "Exterior," are taken outdoors.

The Queerest of Back Yards

The back yard of the Essanay factory is the queerest place imaginable. In size it measures about two hundred by six hundred feet. In the diversity of its possibilities, it measures more than that number of miles. Standing in the automobile tunnel which leads through the building from the street, you see in a semi-circular sweep of the eye all this: A desert, a "lake," a farm yard, a garage, a section of the Wild West, a fashionable residence, a stockade of the days of '49, a beautiful green lawn, smooth enough for lawn fêtes and tennis, and a curious assortment of old stage coaches, hansoms and "props."

The "lake," which is a concrete basin, is hardly more than twelve feet in diameter; yet it serves its purpose well. A scene may be required showing a man in the act of diving into a river. The camera is adjusted so that the lens covers the water only—not the concrete rim. A soft mattress is tied to the bottom to deaden his fall, the actor dives in—and the camera is stopped. When the story is told on the screen, the water ripples away on all sides of the picture, and conveys the desired effect quite as well as if a river or lake miles in extent had been utilized. On other occasions, during garden scenes, the "lake" serves the duties of a fountain, a pipe connecting it with the water main.

The "desert" is a sprawling pile of white sand. Although there are build-

ings and fences within twenty feet of this sand pile, a camera fitted with an extremely narrow-angle lens is employed for taking desert pictures. A horseman appears in the film as solitary as if he were in the heart of Sahara.

There are some pictures that cannot be "faked," however. Occasionally a scenario is written in which ocean or mountain backgrounds or races of various sorts figure prominently. Such films are carried in stock in large quantities. E. H. Calvin, a director and actor, travels about the country taking "stock" pictures for this purpose. Recently he took motion pictures of the Derby Race at Lexington. The film may not be used for months, but it will lie on the shelves in the stockroom until a play is produced in which horse racing is the background. Bits of the Derby race will be inserted as the plot is developed.

Reality to Secure Reality

On the northwest side of Chicago, fifteen or twenty minutes by the elevated from the Essanay plant, is the blockful of studios and factories occupied by the Selig Company.

Only one studio was in commission when I visited the plant, the others serving temporarily as garages and storerooms. "The House of a Thousand Candles" was being produced in a large glass-covered room. The library scene, which is the center of interest of the story, had just come from the skillful hands of the carpenter. It is worth comment. In the first place it was realistic enough to be truly homelike. The walls were not the patently artificial type usually found in a moving picture studio; they were substantial, and their color was soft. A generous library of *real* books lined both sides of the room. At the end was a fireplace with a genuine fire log, and before it a comfortable leather armchair.

Those who are familiar with Meredith Nicholson's "The House of a Thousand Candles" will recall the secret panels of the fireplace, through which John Glenarm, the old house owner, supposedly dead, made nocturnal visits. I searched for the panels in the fireplace of Selig's "House of a Thousand Candles" for ten minutes before I found them—so perfect was the matching of the boards.

How Actors Are Selected According to Type

The ingenuity and the care exhibited in the construction of the panels and, indeed, the rest of the scenic structure, is but part of the Selig system. A year ago, in the Selig's Los Angeles studio, I was shown a card index system for filing the names of applicants. The actors were classified not by name but by type. John Jones was not John Jones at all: he was merely one of a large number of nonentities listed on cards under the index "English Butler." There were several thousand cards in the file together with the telephone numbers of the applicants. If a society matron is wanted, the director consults the file, selects one of the cards under the index "Society Matron," and requests the applicant to call upon him.

In the wardrobe room at Chicago I saw a similar example of this remarkable methodization. There were hundreds of lockers and drawers arranged in tiers and rows about the room. All were numbered and indexed. If one of the directors wants fifty complete uniforms for a Civil War play, or twenty-five Louis the Sixteenth costumes for a story of the French Revolution, he states his wants to the woman in charge of the wardrobe, and the uniforms or costumes are ready in an hour if need be.

Composing Music with the Aid of a Wax Phonograph Record

Of great aid to music composers is the invention of a Swedish inventor. Connecting with the keyboard of a piano or organ is an electric device which transcribes music as it is composed on a wax ribbon, from which it may be copied. Improvisations are then recorded. The idea is not altogether new. Such an instrument, the invention of a Viennese, has long been installed in the German Technical Museum of Munich.

To eliminate the vibration caused by a detachable motor when it is installed in a canoe, a Canadian inventor has devised a form of float that may be fastened to the stern and which carries the motor. Thus the vibration is confined to the auxiliary craft and does in nowise affect the canoe.

A New Type of Detachable Motor for Rowboats and Canoes

Detachable motors have for several years greatly increased the pleasure to be derived from the ownership of a rowboat or a canoe. Much difficulty has been experienced in the past because the vibration from these useful little engines has often strained the frames of canoes to which they have been attached. The weight of the engine is all supported by the extreme stern of a fragile craft. Hence the frame is loosened and the entire hull weakened.

The accompanying illustration shows the method invented by a Canadian motorboat inventor to obviate this difficulty. He has built a floating frame which is to be attached to the stern of the canoe. Buoyed up by air chambers, this frame supports the weight of the engine, and keeps the propeller immersed in the water to the proper depth. Most of the vibration of the motor is taken up by the frame, and the hull is eased of the strain to which it was formerly subjected.

Dyeing Silk Before It Is Silk

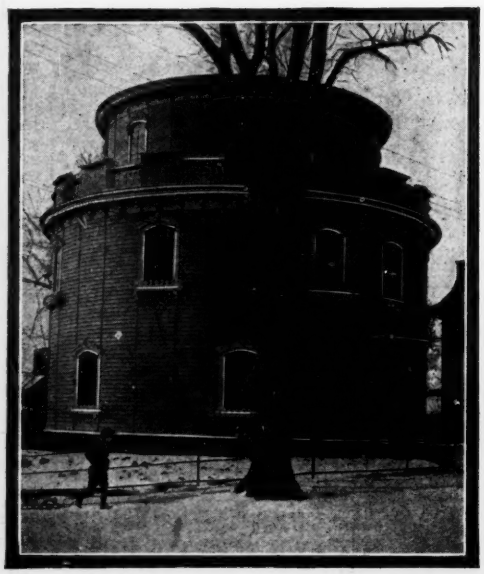
Silk is the secretion of two glands of the silkworm lying alongside the digestive canal. These glands, which consist of numerous coiled tubes, terminate in a spinning-wart. From a common orifice in the spinning-wart the secretion, of the consistency of honey, issues forth, promptly hardening into a thread on exposure to the air. Usually the silk is colorless on leaving the body of the silkworm, but sometimes it is straw yellow or greenish. Why? The answer has been a matter of long dispute.

Some claim that the larva itself produces the color; others ascribe it to impurities acquired upon secretion; still others are of the opinion that the green color of the leaves of the mulberry tree is the cause. Two French scientists, Levrat and Conte, determined to settle the dispute. They fed silkworms on mulberry leaves which had been saturated with non-poisonous aniline red and aniline blue. With what result? Not

only were the silkworms turned red or blue, but their secreted silk assumed the respective colors. Who knows but some day we may be dyeing silk in the leaf instead of in the vat.

A Man Who Built a Round House for Himself

This "Round House," located in



It was an eccentric gentleman who had this bizarre round dwelling house built. It has no advantages other than being conspicuous.

Somerville, Mass., was erected by an eccentric who thought not only that a circular dwelling could be built at less expense than the ordinary frame dwelling, but that more room would be obtained. A circle forty feet in diameter was laid out, a cellar dug, and a solid foundation built. The walls are made of plank sawed to fit the circular foundation and nailed together in regular rows. Nearly two years were required to construct this house, which is three stories in height, and contains fifteen rooms. The door knobs are of glass, with white medallions bearing likenesses of the Presidents of the United States.

A recent electrical invention is in the form of a latch for automobile doors that opens when a push-button is pressed.

Growing Mutton by Electric Light

A novel method for fattening mutton has been recently developed among the big ranchers of Oregon. The sheep pens are wired for many light bulbs, and during the winter the lights are turned on at four o'clock in the afternoon, in other words, at dusk. The sheep feed so long as the pens are lighted. At nine o'clock the lights are turned off until four o'clock in the morning. Feeding recommences. The ranchers claim that this frequent feeding brings them to the market stage very quickly.

A Sprinkling Cart That Carries Its Own Pump

Instead of taking water from a tank or through a pressure pipe, the sprinkling carts on the highways of Marin County, California, make use of gas engines,

Water, whether from a hydrant, tank or pond, is always available to this sprinkling cart, which carries its own pumping equipment.

which are carried upon the rear of each vehicle, and which are used to pump up water for wetting the roads. Such is the abundance of the water available that the system of using a small, gas-propelled pump makes it unnecessary to build expensive tanks and permanent pumping plants for the use of the water wagons.

A New Food from the Sea

By Charles Alma Byers

ALONG the coast of southern California there is being rapidly developed a new sea-food industry that threatens to rival the canning of salmon. The new material of this newly established industry is the tuna fish. In 1913, 115,000 cases, of four dozen one-half and one-pound cans each, were put up and disposed of, and in 1914, with ten companies engaged in the industry, the output amounted to nearly 300,000 cases, valued at $1,500,000. Experiments in canning tuna had been made for about three years, but not until 1913 was a commercially successful method evolved.

The tuna fish which is canned is more properly called albacore. It belongs to a branch of the tuna family. The real tuna frequently weighs as much as one hundred and fifty pounds, whereas the albacore rarely exceeds one-third of this weight. Because of the family connection, however, the Government has permitted the product to be labeled tuna, under which name it is marketed.

Both the albacore and the tuna proper are game fish, and have long been familiar to the deep-sea fishermen of southern California. Certain species of the tuna have been found in various parts of the world, notably in the Mediterranean, but so far the albacore branch has been found only in the waters of the California coast. And even here they seem to be confined exclusively to the stretch of water extending from Santa Barbara to San Diego. In season—that is, from about the first of June to the middle of January—they are found in large quantities.

The fish employed for canning purposes range in weight from fifteen to forty pounds. Because of their size, they must be caught with hook and line. All attempts to take them in nets have failed. Since they run in large "schools," two or

Although a newly established industry the Tuna Canning activities of Southern California are already said to be seriously threatening the canning of salmon. Here are seen the women workers in a typical cannery. The fish are first beheaded and hung by their tails to drain. All the skin and bones are then removed—the white meat only being used—and the useful portion baked in large ovens. The packing then takes place, a single piece being allotted to each can, in salad oil.

four fishermen, in a gasoline launch, will daily return to port with from six hundred to four thousand pounds of fish. Small sardines are used for bait. The fishermen are mainly Japanese. The fish is extremely powerful, and fights hard. It is of steel-blue color, is very solid, and is of true torpedo shape. During the past season, nearly one hundred boats were regularly engaged in tuna-catching for the canneries.

The fish are first beheaded, and are hung up by their tails in the packing house to drain. All skin and bones are removed. Only the white meat is used, which is baked in large ovens, and then packed, usually a single piece to each can, in salad oil. The product has a taste not unlike that of chicken, and is very much in demand wherever introduced.

Cleaning Four and a Half Miles of Water Main With An Internal Scraper

The difficult task of cleaning a long water main of large diameter without seriously interrupting the service has been recently completed at Merced, California.

The main, 24,570 feet long, had been in continuous use for 27 years, and had been so much incrusted that its service was becoming inadequate. It had been found necessary, when a full peak load of water was needed, to augment the service by drawing water from wells by three large pumps installed for the purpose.

The device for cleaning the pipe was a self-propelled machine, built on the principle of the water turbine motor. The water pressure behind the machine forced it through the pipe, at the same time rotating the vanes and scrapers that removed the incrustation. The entire length of main was cleaned without removing the machine from the pipe. The material removed made a pile ten feet in diameter, and four and a half feet in

Do you believe that water supply pipes are scrupulously clean? If so, take a look at this little mountain of sediment that was removed from a water main at Merced, California, 24,570 feet long. The device seen at the left, especially intended for the purpose of cleaning w ater mains, was used for the task.

height. The contract was fulfilled to the letter, and the contractor received a bonus for increasing the capacity of the pipe beyond the terms of the contract. The cost of removing the incrustation was fifteen cents per linear foot.

Radium in the Air We Breathe

Researches have been made to ascertain whether there is any relation between the state of the weather and the electric condition of the atmosphere, but not with much success. Recent investigations indicate a plausible reason for this failure. The earth is continually exuding a radioactive emanation, which electrifies the atmosphere from below and interferes with the measurement of electrical charges due to aerial movement—exactly what the student of the weather is trying to get at.

Experiments show that the air in an empty water-tank of about six hundred and fifty cubic feet capacity is as radioactive as if it contained a small ascertained proportion of radium bromide. It follows that if the atmosphere covering the land surface of the earth is as active as the air in Montreal, for example, for an elevation of six-tenths of a mile, six hundred tons of radium bromide evenly distributed over that surface would continue to produce emanation sufficient to equal in its effects those observed in the case of the empty water-tank.

Vessel's Whistle Dislodges Glacier Ice

Dislodging thousands of tons of ice by a mere blast of a whistle was the remarkable feat performed on an Alaskan steamship. It took many hours for the captain to get his ship in the right position. Finally he struck the right point and the vibration from the whistle caused tons of the ice from the Taku Glacier to come crashing into the sea. This glacier is located in the southeastern part of Alaska. The steamship had to sail very near to the shore to perform the feat. Tourists declare that the spectacle of the tumbling ice surpassed even the sights further north on the Alaskan trip.

An aviator and his passenger may be only three feet apart, yet they cannot converse without the use of telephonic apparatus of special design.

Telephones on Fighting Aeroplanes to Talk Over Three Feet

Military flying machines usually carry two men—a navigator and an observer who must also work a machine gun when he has to beat off a meddlesome enemy-aviator. It is hard—almost impossible—for the observer to communicate with the navigator because of the motor's deafening roar. Hence, it was found necessary, even before the present war, to strap telephone sets on the heads of the men in flying machines. Turner, the inventor of the dictagraph, has devised a special loud-speaking telephone for the use of men in the air, an instrument of extraordinary power, which has been recently adopted by the Russian and Italian air fleets. Since everything must have a name Turner calls his invention an "aviaphone."

The mouthpiece is large, and is held in position by a plate strapped about the chest. Two receivers are used. They fit under the helmet. The instruments are very sensitive, and magnify the sound, so that it is not drowned by the motor.

Floating Metals

If a small piece of iron—a straight piece of wire, for instance—be greased, it can be made to float on water. Apparently the grease prevents the breaking of the surface of the water, and the iron lies cradled in a slight depression or trough. In recent experiments with rods and rings of iron, tin, copper, brass, platinum, aluminum, German silver, etc., it was found that all metals, even the heaviest, will float on water when their surfaces are chemically clean.

A perfectly clean piece of copper or platinum wire, for example, forms a trough for itself on the surface of the water just as if it were greased. The same is true of a small rod of glass. The floating is due to a film of air condensed on the surface of the glass or metal. Why? If the rod be heated to redness, cooled, and immediately placed on water, it sinks. But if it be exposed to the air for a short time it floats.

PEACE FLEETS OF THE UNITED STATES

THE U. S. Government has its peace fleets as well as its war flotillas. They carry no guns, for their purpose is constructive, not destructive; yet they are commanded by some of the ablest officers in the service and are actively engaged for many months of the year. The largest of the peace fleets are maintained on the Upper Mississippi River. If all the several hundred steamers, barges and crafts of various other kinds comprised in these peace fleets should assemble and move down the great river together, they would make quite an imposing spectacle.

A Government scow unloading stones on a bank to prevent the water from undermining the shore. In the oval: The building of a dam.

It is the work of the peace fleets to make the wandering Mississippi stay put in one main channel — a channel so deep and wide that it will afford easy passage at all times to the big freight and passenger steamers north to St. Paul. They are accom-

One of the peace fleets of Uncle Sam engaged in keeping the treacherous Mississippi River under control and insure free navigation to the many steamers that ply its waters.

plishing this by digging up and carrying off sand bars, pulling snags, reveting hundreds of miles of banks that wash and send sediment into the river, and building thousands of dams from the shore into the channel to turn the spreading waters and keep them flowing in one main course.

The river is divided for work between St. Paul and St. Louis into seven divisions with a resident Army Engineer on each division and a fleet consisting of three steamers, three quarter boats, two dam-building barges, a riprapping outfit, a pipe line dredge and 25 to 30 barges for hauling. Since much of the work is done at too great a distance from towns to allow the employees to go back and forth, the boats are fitted up as a home for them. Two big double-deck quarter boats are used by the laborers. A third is the home of the Army Engineers and their assistants and has a suite of modern offices in addition to living and sleeping quarters.

As soon as the ice moves out in the spring the seven fleets leave winter quarters and take up the work of dam building at different points on their divisions. The quarter boats tie up at the shore at the place of construction and the work boats and barges ply the river nearby.

A third of the contract to make a six-foot channel to St. Paul that the War Department has undertaken is already achieved, and the engineers in charge of the fleets are confident of the ultimate accomplishment of the whole project.

Blasting Coal with Water in German Mines

In German coal shafts there is being practiced a method of mining that is said to do away with dangerous blasting, while also avoiding much of the risk of spontaneous explosion of coal-dust. Deep holes are bored in the coal and water is introduced into them by pipes under heavy pressure. The water finds its way through the coal fissures and opens them up until the mass is loosened, when it is readily removed while wet without any dust or the use of any tools other than a light pick and shovel.

A Plant That Made a Seat Out of a Millstone.

Some years ago a huge millstone which had been used in a South Dover, N. Y., mill, was discarded. It lay on the ground for a long time. One day a tender plant poked its head through the hole in the center of the stone and grew up with it.

The Real Cost of a College Education

Statistics have recently been given out by the University of Wisconsin which show the average cost of a four-year college education, both to the pupil and to the taxpayers. According to these figures, it costs $211.65 to give each student instruction for a year. Of this amount, the taxpayer is forced to pay $149.05, the rest being made up by state and federal grants, special fees and gifts.

In addition to this sum, the pupil has to pay his share of the expenses, for board, clothes and incidentals. This averages about $300 a year. Another item to be considered is the value of the time lost in college when the student might be at work and earning money. This might average another $300 a year. Hence, the average cost of a college education amounts to $800 per academic year, or $3,200 for a four years' course.

A Railway Lunch Counter for Golfers

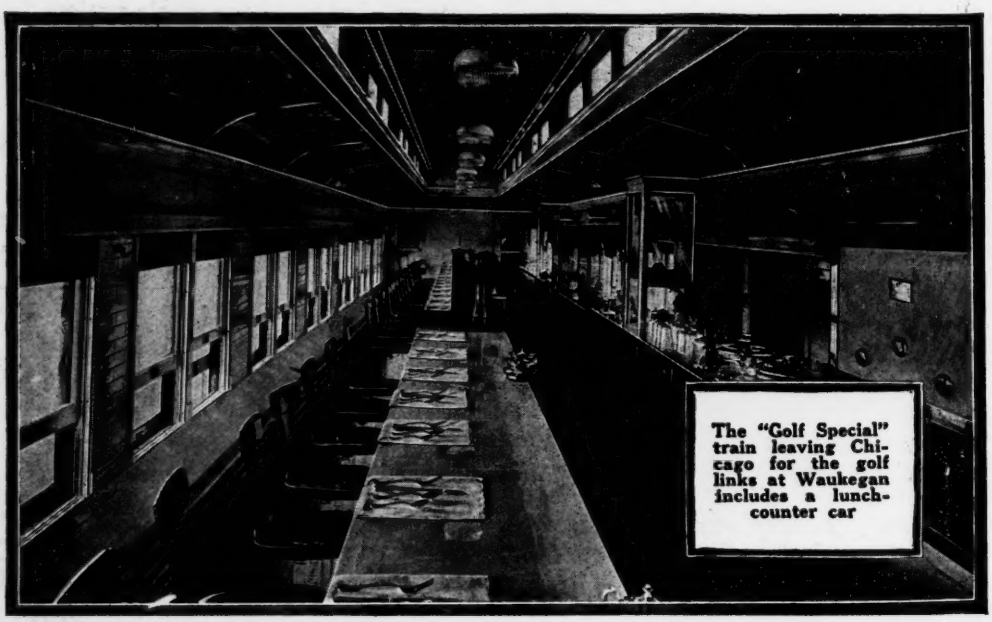
For the convenience of the hurried business man who is often confronted with the necessity of choosing between a hasty lunch or the possibility of missing his train to the golf links, a middle western railway has added to its "Golf Special," a first-class train leaving Chicago about noon-time for Waukegan and the golf links, a lunch car which is a model of comfort, cleanliness, and efficiency.

A lunch counter which extends nearly the full length of the car is fitted with twenty-seven comfortable revolving seats.

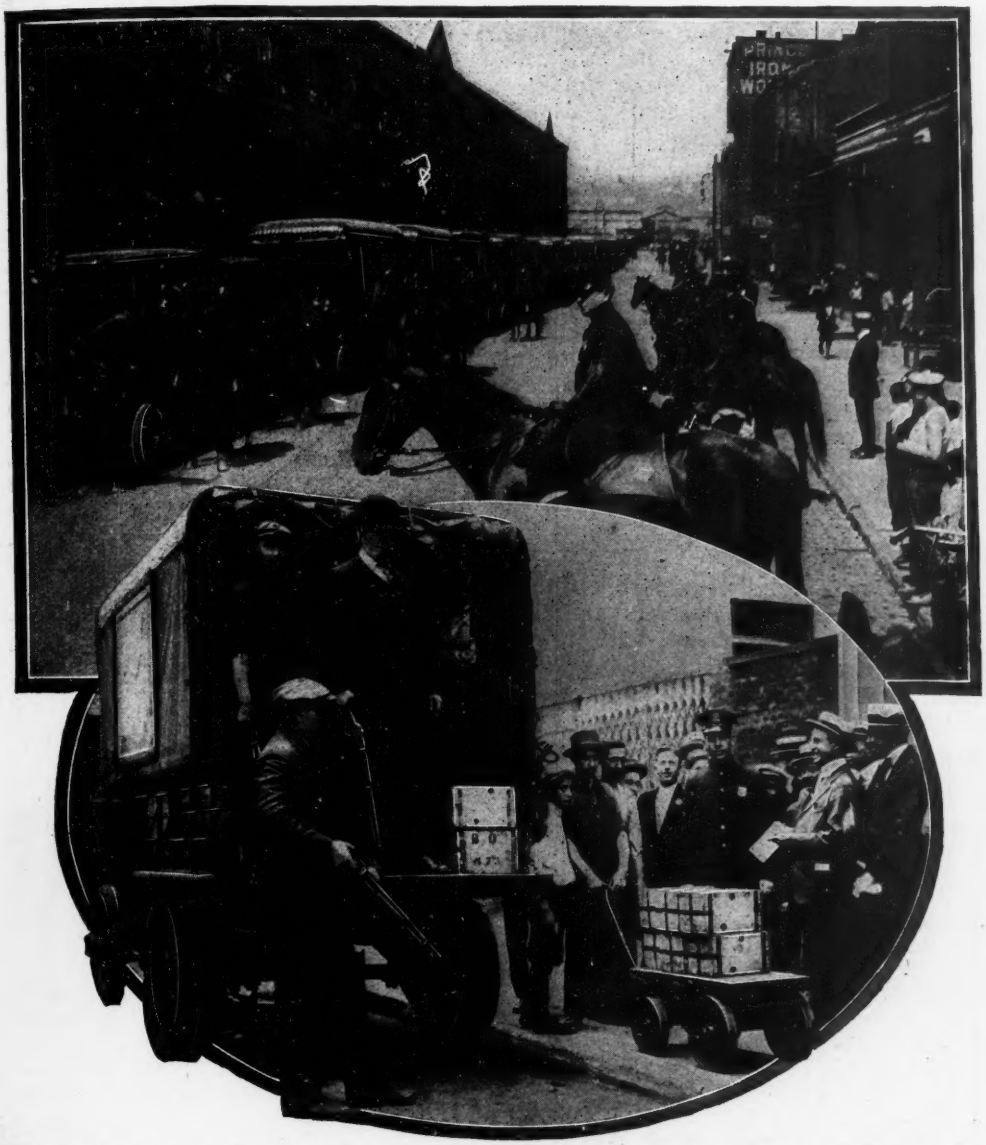
A Treasure Caravan in New York

The sight of twenty-five gold-laden automobile trucks, manned by numbers of men carrying repeating rifles and escorted by a cavalcade of mounted police, brought the traffic of Wall Street to an abrupt standstill recently. The trunks contained $50,000,000 to pay for war munitions and other supplies, of which vast sum $19,534,200 was natural gold.

Thousands of spectators, who had read in their papers that morning of the tremendous shipment of gold from the Bank of England to J. P. Morgan & Co., stood spellbound while watching the treasure caravan roll past.



The "Golf Special" train leaving Chicago for the golf links at Waukegan includes a lunch-counter car



Carrying British gold and securities amounting to the value of $50,000,000, twenty-five automobile trucks recently wended their way through the streets of New York City, guarded by a cavalcade of mounted policemen and numerous men armed with Winchester rifles.

The eyes of the guards, of the mounted police, and of detectives constantly watched the crowds. Some of the guards nearly collapsed from the strain, for they had been constantly on duty during the twenty-four hours' journey from Canada to New York City.

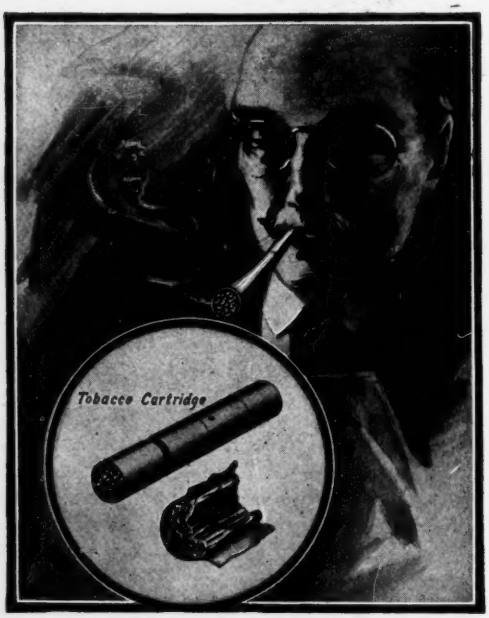
The treasure, which had been brought by a fleet of English warships, was forwarded to New York in a train of seven steel cars. Three miles in front ran a dummy train of five cars, to receive any attack which might be made. Only five cars contained the treasure in the second train. The first and last cars were empty, so as to serve as buffers in case of a wreck. Forty guards, armed with army rifles, vigilantly sat in the cars during the entire trip. Every precaution was taken.

When it arrived at New York, the train was met by a strong detachment of police. The work of unloading the heavy boxes of gold from the train into the twenty-five covered automobile trucks was done with great care and dispatch.

When the procession drew up before the doors of the Sub-treasury, an immense crowd gathered, but the large number of policemen and guards kept the curious at a safe distance. Checkers for the Government, J. P. Morgan & Co., the express company which handled the shipment, and the British Government, carefully watched the unloading and the final opening of the boxes.

Tobacco in Convenient Cartridge Form

Sportsmen, tourists, and lovers of outdoor life, to whom compactness must always hold a peculiar charm, will consider this new form of tobacco and smoking-tube a distinct advance over the bulky old tobacco can and the bulging rubber pouch. "Tobacco cartridges" the new article has been named; for the roll of tobacco that goes to make this device has been cut transversely into a half dozen tubular plugs, each of which, in the manner of a soldier's cartridge, may be removed from the roll and inserted into a pipe or holder, and smoked just as readily as ordinary pipe tobacco. Thus has the military idea of the compactness and easy manipulation of a cartridge been adapted to the smoker's enjoyment. Furthermore, these cartridges, instead of containing shreds or strands of tobacco, are made of the entire leaf, which is rolled together and folded so as to obviate the drying up and wastage of the old fashioned cigarette. In this way, one's pipe tobacco, or chewing tobacco, may be carried in a small, neat, sanitary roll; and at that silent after-lunch command "Light up," one simply removes a cartridge of tobacco, loads his pipe, and puffs contentedly away.

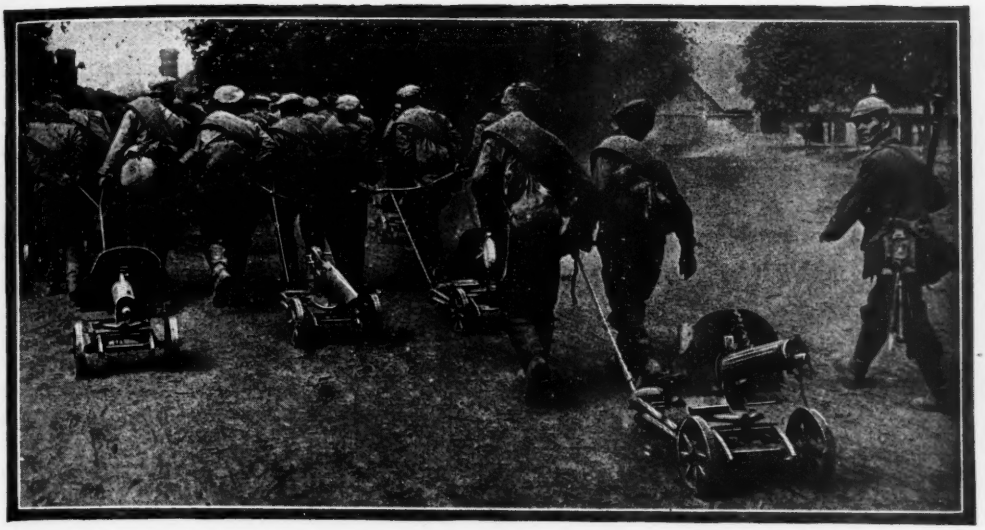


Do you admire compactness? Here is the latest examples of it: Tobacco made up in the form of cartridges and smoked in a special holder.

Although these tobacco cartridges may be smoked in any regular pipe, a smoking-tube is suggested for use with this form of tobacco. In principle, it is simply a cigar holder with a larger and deeper bowl, tapering towards the stem, so that the cartridge may be more tightly gripped until it is entirely consumed. One side of the tube, which is slightly curved, is flattened so that it may be placed on any flat surface, without the possibility of burning the varnish or contaminating the mouthpiece.

An "All-Electric" Village

Wildwood, a suburb of Toledo, Ohio, may be truthfully called an "all-electric" village. A large real estate development company has erected this little village of thirty houses, and has equipped them throughout to be operated by the latest electrical devices. Each house is fitted out with a large electric range instead of the old-fashioned cook-stove or range. The real estate company purchases the current for the entire village in bulk from the central station and retails it to the householders, who are thus able to obtain their power at a reasonable rate.



Russian infantrymen and their machine guns captured by the Austro-German armies in the vicinity of Warsaw in Poland. The machine guns in this instance are mounted on small carriages to permit of ready transportation

The Machine Gun—The War's Greatest Terror

ALTHOUGH the Gatling gun—a weapon consisting of six connected barrels revolving on a common axis—was a remarkably efficient weapon for its day and wrought its share of havoc in the Civil War, and although the French used a *mitrailleuse* in the Franco-Prussian War—a gun with no less than thirty-seven barrels—it was not until Hiram Maxim in 1883 invented the automatic weapon that bears his name that we really had a true machine gun. Ingenious Yankee mechanic that he is, Maxim hit upon the idea of making the "kick" of the gun perform every operation from loading to firing. Before his time machine guns had all been operated by hand. When smokeless powder was discovered, the Maxim machine gun came fully into its own; for then it was possible to take up a concealed position and squirt death without betraying clouds of smoke.

Since England has always had a war on her hands with some savage tribe, it was but natural that the British army should have given the Maxim machine gun its first practical test. In the Matabele campaign of 1893, the Afghanistan war of 1895 and the Mahdi conflict of 1898, the frightful demoralizing effect of hundreds of shots discharged almost like water from a hose was convincingly demonstrated. During the Spanish-American war of 1898 and the Boer war of 1899-1902 the Maxim machine gun was first used effectively against civilized people. If there was any doubt as to the efficacy of the weapon—it had been argued by some conservatives that the gun was much too complicated and that it jammed too easily—it was dispelled during the Russian-Japanese war. Such was the deadly effect of the machine gun in Manchuria that every European power at once increased its machine gun contingents. After the Balkan campaigns of 1912 and 1913 it was generally conceded by military officers that neither infantry nor cavalry could be effectively used without the assistance of the machine gun.

The older Maxim models weighed about fifty-five pounds. By skillful designing the Germans reduced this to thirty-five pounds. The latest English Maxim model is still lighter, weighing but twenty-five pounds.

The machine guns used in the present European conflict all fire infantry cartridges. The opening of the breech, loading, closing of the breech and firing are absolutely automatic so long as the marksman keeps his finger upon the firing trigger. Since as many as six hundred shots may be fired in a minute, ammunition must be supplied in great quantities in an uninterrupted stream. To accomplish this the cartridges are fed either in belts or in metal magazines. Such is the rapidity of the fire that the barrel becomes dangerously hot. Hence every machine gun of whatever make is provided either with a water jacket, like an automobile cylinder, or with cooling flanges and projections. For this reason machine guns cannot be built in a size and weight with that of the infantry rifle.

Although Maxim's original idea of using the "kick" or recoil in order to perform the functions of loading and firing still meets with approval, machine guns are also in use in which, not the recoil of the barrel, but the pressure of the powder gases is made to operate the piece. The Hotchkiss and the French Berthier gun are perhaps the best examples of this type. The inventor of this gas-pressure type is Freiherr von Odkolek, an Austrian officer. All these guns are cooled by air with the exception of the French Berthier.

A water jacket is the most effective means of cooling the gun. In order that the steam arising from the water may not betray the position of the piece, it is conducted by a hose either to a water container or to the ground, where it is quickly precipitated. Glycerine is added to the water in order to prevent it from freezing in winter. While air-cooled guns are free from the objection of generating steam, they are necessarily much more complicated. Most of them are provided with pumps which automatically drive air through the passages to be cooled.

The early machine guns were carried on wheeled carriages like ordinary field pieces. That proved a serious error, because they were much too easily seen at a distance. Consequently tripod mounts were soon adopted. This tripod mounting is usually detached from the gun during transportation.

While on the battlefield the parts of a machine gun (tripod, barrel, ammunition, and so on) can be carried by infantrymen, as the cover design of this magazine shows. Over long distances, however, the guns are usually hauled by animals or cavalrymen. The vehicles on which the infantry weapons are transported may serve to carry part of the crew, as in the German army. In the French, Austrian, Japanese and Russian armies machine guns are carried by animals entirely and the gun crews march on foot. In the German, Dutch, French and English armies cavalry machine guns are carried on vehicles and the gun crews either ride on horses or on the vehicles themselves. If only animals are used for transporting cavalry machine guns, as in the Austrian, Russian and Japanese armies, the gun crews are, of course, all mounted.

Machine guns are carried by horses, mules, dogs, motorcycles, automobiles and sleds. Indeed almost any kind of vehicle can be employed for transportation, which is speedy and not too conspicuous.

Aeroplane Secured by National Guard and Naval Militia

In the midst of the agitation to equip the National Guard and Naval Militia of the various states with aeroplanes and flying boats comes the good word that the Naval Militia of the State of New York has already purchased a Curtiss flying boat of the latest type, and expects within a few weeks to hold practice flights in the Hudson River off Ninety-seventh street.

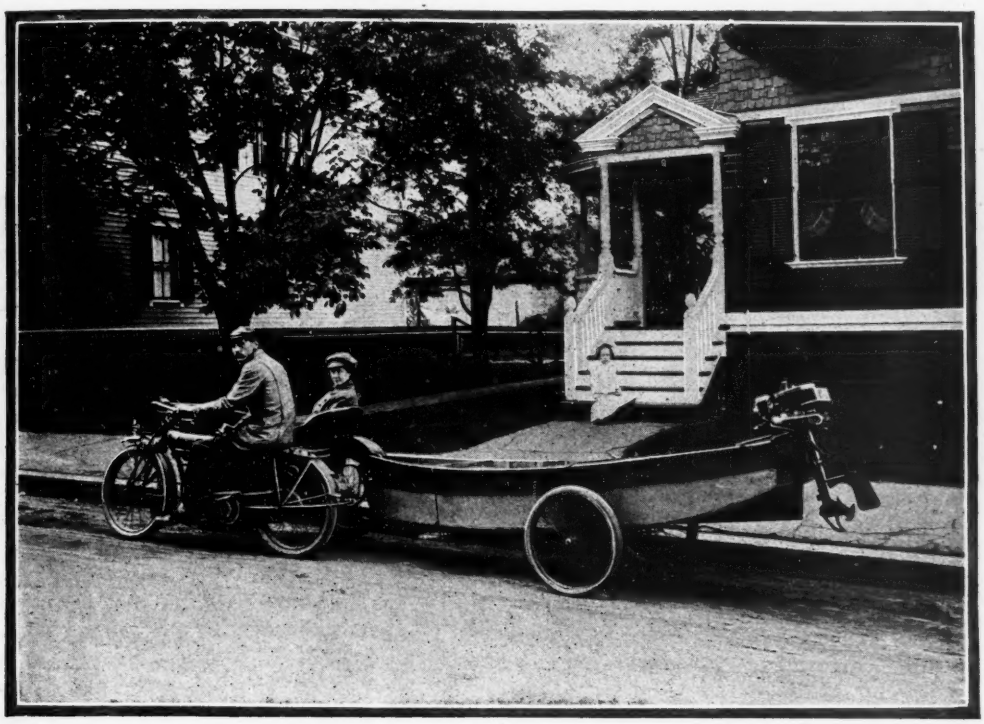
Two members of the battalion are now at Hammondsport, N. Y., at the Curtiss factory, learning to fly and acquiring a thorough knowledge of the motor.

The commanding officer of the battalion has been flooded with applications of the militiamen to be assigned to the aeronautical corps, and by a weeding-out process it is expected to find a group of very efficient men to navigate the hydroaeroplane.

A Chance for the American Motor-Maker in China

The American consul-general at Shanghai, China, believes that there is a large field for motor boats and engines in that country. He says that there are thousands of small craft plying the numerous inland waters and canals of China, and that few of them are equipped with motors. He hopes that at least a small percentage of this great fleet of boats will be equipped in the near future with American motors.

He fits a detachable motor to a small, flat-bottomed skiff and places the whole on a two-wheeled steel carriage. This he attaches to the side-car of his motorcycle by means of a swivel bolt. His wife he disposes in a side-car and his fishing rod and lunch in his boat. Thus equipped, he sets off at top speed for any of the numerous ponds, rivers or harbors which abound in the neighborhood of Providence. This suggestion might well be followed by owners of motorcycles.



How is this for an outing suggestion? A Providence man and his wife travel to a distant lake, river or seaside on a motorcycle and side car, hauling a fishing boat mounted on a light bicycle wheel truck behind them. Once they arrive at the water's edge, the boat is slipped into the water, the gasoline motor turned on and they are off for a marine trip.

A Fishing Boat Hauled by a Motorcycle

Mr. B. A. Swenson, of Providence, R. I., has apparently solved the problem of how to own a motor boat on each of several far-away fishing grounds, and how to reach them quickly in his leisure hours—all on a moderate income.

How Smoky Is the Air? An Instrument That Tells

John Lowden, a Scotchman, has invented a "smoke tintometer," which, it is thought, may be of use in prosecuting cases of "smoke nuisance."

It consists of a tube with a single eyepiece and two object openings. One of these is clear, but the other contains a revolving diaphragm in which are set five circles, one of clear glass and the

other four of tinted glasses corresponding with the standard tints of a scientific "smoke-chart." In examining smoke-defiled air the diaphragm is turned until the tinted glass coincides in darkness with the air seen through the clear aperture. The various glasses are systematically numbered, so that a glance suffices to show the degree of defilement of the air.

The Evolution of the Self-Starter

From a heavy, cumbersome and somewhat undependable piece of machinery to a small, compact and never-failing unit is the evolution of the automobile self-starter in the last four years. The accompanying illustration shows graphically the relative sizes of the different models, from the top machine, which is the 1916 model, to the bottom, which is that of 1913. The most recent model, that of 1916, weighs 14 pounds. Last year's car carried a self-starter weighing 24¼ pounds. In 1914 the weight was 34½ pounds, well under half that of the previous model, which tipped the scales at 80¼ pounds. The starters mentioned are of the electric type.

Four years of the automobile self-starter: Here are seen the electric self-starter machines of the past four years; the bottom one being the first model and the other three, in the order shown, the succeeding ones.

A Californian has invented a machine that pumps warm air out of a freight car and replaces it with cold air for the purpose of refrigeration.

Mysterious Zone of Silence Observed in Testing Distances Big War Guns Can Be Heard

In making observation as to how far heavy artillery fire can be heard, scientists have discovered the unaccountable phenomenon of a zone of silence. Although heavy detonations could be heard at distances of a hundred and thirty-nine and a hundred and forty-two miles, there was no sound audible at points from forty to one hundred and six miles away from the location of the heavy mortars used in the attack on Antwerp. At the point where the detonations could again be heard; that is, at a point about one hundred and six miles from the artillery, the reports and concussions were especially violent and severe; for the ground trembled perceptibly.

This war is a scientific demonstration of the existence of such a soundless zone, reported in history. When Frederick the Great defeated the Austrians near Liegnitz in 1760 zones of silence aided him. The main body of the Austrians, stationed nearby, did not hear the artillery fire, and, as a consequence, failed to come to the support of their companions, while other Austrian troops, much further removed, heard the cannonading and started for the scene of activity, but arrived too late to be of any assistance.

Zones of silence are often encountered in navigation.

What Is It? Boat or Automobile?

A Vienese inventor, Ludwig Zeiner, has invented an automobile-boat or a boat-automobile, whichever you choose to call it. When it travels on land it looks pretty much like an ordinary racing car, for its hull is modeled on the lines of a torpedo car body. And when it crosses a river it looks for all the world like a motor boat for the same reason. If it were not for its propeller no one would suspect that the vehicle is as much a boat as it is an automobile.

A four-cylinder motor of sixteen horsepower drives the automobile-boat at a speed of forty-five miles an hour on a road and twelve miles an hour through water.

On land this vehicle can attain a speed of forty-five miles an hour, and twelve miles an hour on water.

The passengers in this automobile-boat are equally prepared to travel on land or water.

There is no stoppage before the automobile takes the water. It plunges down even a steep bank and pushes its nose into the water at once. When dry land is reached again it climbs out just as readily.

Other vehicles of this type have appeared in the past, but perhaps none have been as practicable.

Forcing Plant Growth by Acetylene

It appears that acetylene gas is being utilized as an adjunct to the sun in the cultivation of plants. Plants subjected to the light of this gas are reported to attain twice the size of those left to the rays of the sun only, and vegetables are said to have attained dimensions double those unassisted in the matter of illumination.

The experiments were conducted during a period of three months and in a hot-house. This house was divided into two parts by means of a curtain, the curtain being hung in such a way that each half of the house received the same illumination from the sun. The beds on each side were exactly alike, not only in size but in location and contents. If a lily were planted in a certain part of a bed on one side, another of the same species and age was set out in the same part of the corresponding bed on the other.

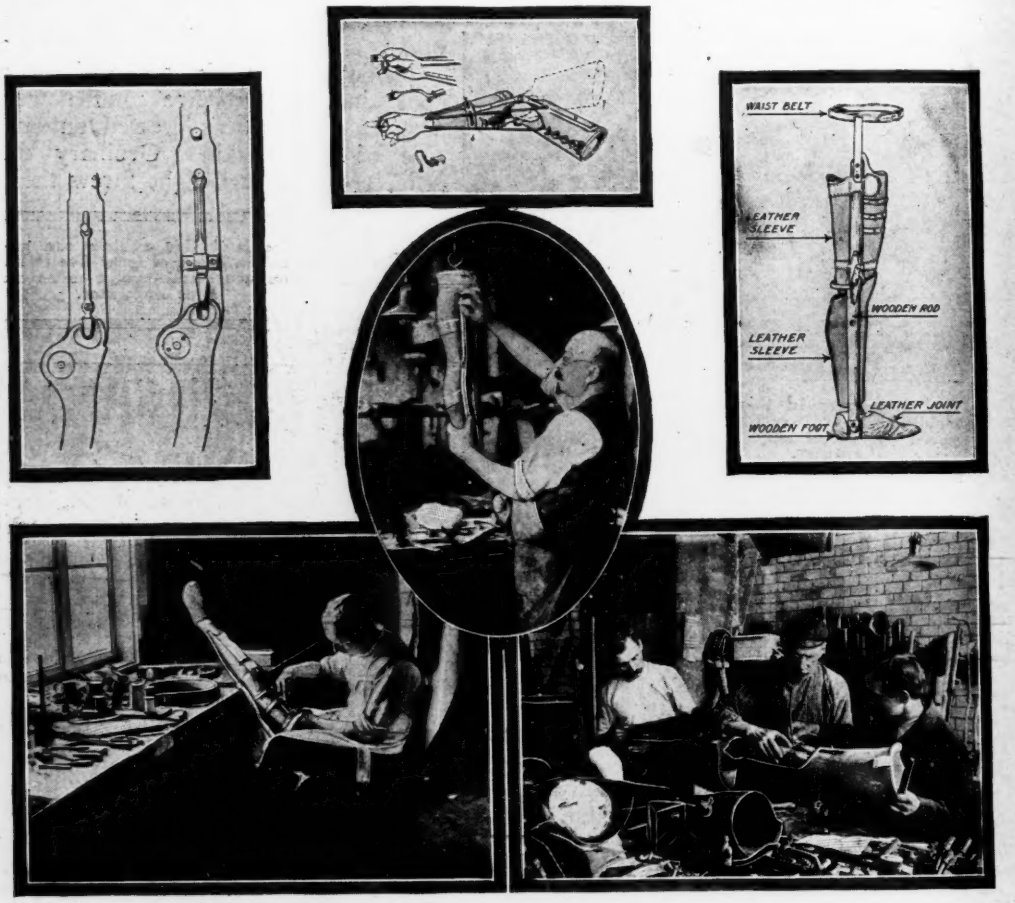
Inside the curtain an equipment consisting of thirty-five candlepower acetylene lamps was erected on one side of the curtain. Ordinary tin reflectors over each light threw their rays downward upon the soil. The lights were operated whenever it was dark, the length of time varying from nine to fourteen hours, according to the period of daylight.

The plants on the acetylene side were found, in many instances, to mature with twice the rapidity of those on the other side of the partition. Radishes, onions and several other species that develop their edible portions below the surface of the ground were found to have pursued their usual course, except that they grew twice as fast as those not placed under the influence of the acetylene light.

Man-Made Limbs for Limbless Men

IN the stress of circumstances created by the great European war, France is already casting her glance ahead towards the future, when her maimed and crippled defenders will return from the battlefields to their beloved hearths. France is aware of the great debt she has contracted towards her gallant sons; and even now, with the end of the struggle not yet in sight, a great movement is under way to give to the crippled victims of the war the material and moral aid which they have so bravely earned. The French Republic is planning to provide her maimed sons with artificial legs and arms, so that the crippled veteran, far from becoming an object of maudlin sentiment or a hopeless pensioner, will actually be enabled to take his place in the trade or profession to which his injuries limit him.

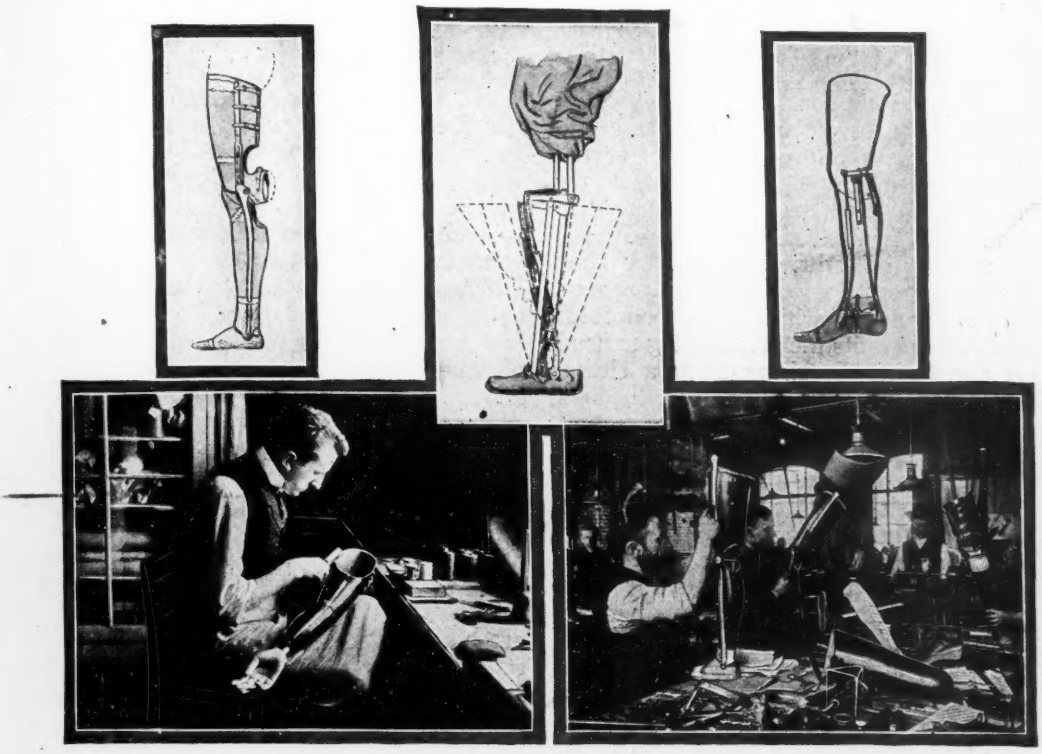
If the social question of the readjustment of the cripple to his environment is a complex one, the mechanical question is more easily solved. For, given a good artificial limb, the armless or legless man



A collection of views of the French workshops where limbs are being made in large quantities for the men who have been maimed while fighting the battles of the Republic. In the other views, showing the mechanism of artificial limbs, the first one illustrates the sliding bolt mechanism of a leg. While walking the bolt is pushed down so as to engage with the catch in the lower member, the leg being thus kept rigid. When the wearer of the limb wishes to sit down, the bolt is pulled up so as to permit of folding the artificial leg. The second sketch shows a typical artificial arm as well as the implements used in conjunction with it. The third view illustrates an artificial leg with the various parts indicated.

can readily move about, easily take to an occupation, and be quickly enabled to "stand on his own legs," both in the physical and economic sense.

stump which, on account of its ugliness, is not very popular. Yet in its lightness and in its ease of management it possesses a decided advantage over the



Experts engaged in the making of artificial legs and arms for the French soldiers. So skillfully made are these limbs that in almost every instance the maimed soldiers will be able to earn a livelihood and not become hopeless pensioners. The sketches showing the mechanism of the artificial limbs are as follows: The first represents the artificial leg devised by de Beaufort for cases where the leg has been amputated above the knee. The second indicates the mechanism of the leg designed by Professor Delbet, which operates on the principle of the swinging parallelogram. The last is a leg of American manufacture. The leg is thrown forward for a new step by means of a spring

Although the ideal artificial limb is still to be devised, there have nevertheless appeared several models in France which approach a solution of the cripple's problem with a high degree of skill and efficiency. There are, of course, extreme cases of amputation, which even a perfect artificial limb alone will fail to relieve. In the case of an amputated thigh, for example, no device can enable the patient to regain his normal walk. The use of an artificial limb in this instance is attended by a painful movement of the hip, making imperative the use of the old-fashioned wooden crutch.

Next, after the ordinary crutch, comes the use of the time-honored pestle-shaped artificial leg. Cripples provided with this device, especially those whose operation has left them a long stump, have been known to run and jump, to mount stairs rapidly, and even to ride a bicycle.

The most popular and the simplest mechanical leg is that made by de Beaufort and used in cases where the amputation has been made beneath the knee-joint. The portion above the knee is strapped around the thigh, which is supported by two wooden or steel rods, jointed at the knee and extending down along the tubular leather leg into the wooden foot. A steel spring is concealed within the leather leg-piece so as to permit the foot to conform with the walking

movements. This device earns its popularity because it enables its wearer, after several weeks of practice, to resume a gait that is almost completely normal.

De Beaufort's artificial limb may be employed in cases where the amputation is above the knee, but here the knee joint ceases to be free. Consequently, an artificial knee-joint must be supplied, either in the form of an ordinary locked bolt, or in the more improved form of an adjustable bolt. In the former device, the head of the bolt is permanently held in its socket, so that the cripple is required to walk with a stiff, sidling gait. When he desires to sit down, he must press on the upper lever, which thereupon folds back and permits the artificial leg to bend at the knee. In rising from a sitting posture, the bolt becomes erect through the rising motion. The adjustable bolt differs from this device in that it permits the leg to articulate during walking; but it is of such an extremely detailed construction that it is recommended only for those cripples who are capable of concentrating their attention for long periods of time. Internal springs, or even two stout rubber bands connecting the thigh and the leg, carry the latter forward when the whole limb is off the ground. The adjustable bolt may be also used to make the entire limb rigid, by simply allowing the bolt to slip into the socket.

Still another artificial limb has been devised by Prof. Pierre Delbet. In its operation it employs the principle of the swinging parallelogram. The wooden foot, which is attached to a stirrup-shaped knee by means of two pivoted steel rods, is carried forward by the springs whenever the body is brought forward, and the limb raised from the ground. Owing to its great flexibility and adaptability to almost any movement, it is by far the most desirable limb for a cripple who seeks speed in his activities —and there are many in this class.

American made artificial limbs are also found on the French market. One model has a wooden foot which is articulated by means of a four-pointed steel bolt, which, with the aid of springs concealed in the hollow leg, allows a free and jointed movement in walking. Since it is made entirely of wood, it dispenses with steel supports and a leather tube; hence it gains in lightness. The American manufacturers will doubtless find a ready market for artificial limbs in Europe after the war.

Not so much attention is devoted in France to the manufacture of artificial arms and hands, for they are considered merely as esthetic apparatus with which practical and useful movements are impossible. One form of limb is used in cases where the forearm has been amputated. The thumb and the index finger are both jointed; and by means of two strings attached to the steel frame, they may be extended so as to grasp small objects.

The entire movement for providing cripples with artificial limbs has become one of national importance in France. Numerous associations with this object in view have been formed in many sections of the Republic. And the fact that they are patronized by the civil and military leaders—the famous General Pau, for example—bids fair to insure the success of the movement.

A Jail on Wheels

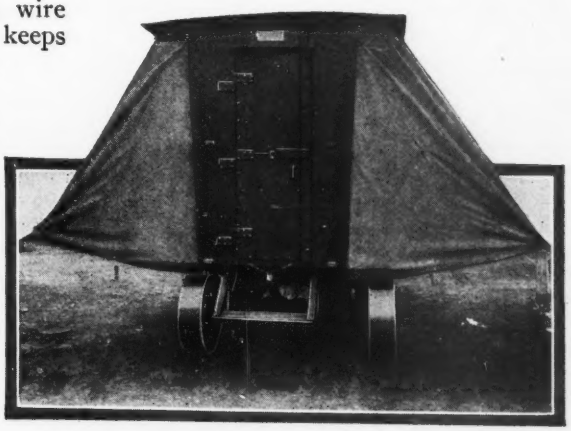
Prisoners of Atlanta, Georgia, who are lucky enough to find themselves in the "honor squad," will have reason to congratulate themselves that good behavior has earned for them comforts denied convicts in most jails. The Fulton County commissioners decided that they would have no unsanitary convict camps and ordered a fleet of specially designed convict cars. Gaze upon them in the accompanying pictures. They are comfortable padlocked cells on wheels. Thirty-six of these cars will form the nucleus of Atlanta's "honor camp."

Each car holds from twelve to eighteen

men, and each man sleeps on a wire spring bunk. Forced ventilation keeps the air pure, and a heating system is employed for cold weather. In rainy weather the cars are fitted out with tents to shelter the prisoners.

The camp can be moved on short notice—men and all. It reduces the guards required ordinarily and protects against disease and vermin.

The Atlanta honor camp will have many modern facilities, including a special dining tent, reading room, carpets, spring cots and other conveniences not usually found in places of detention.

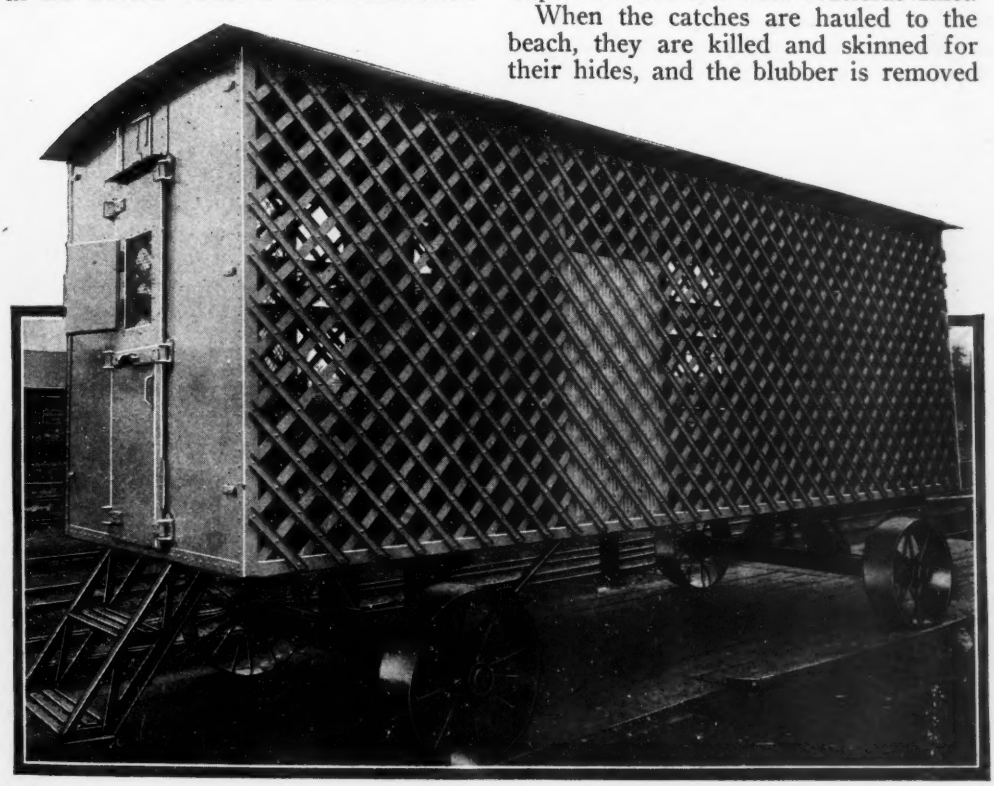


A traveling prison with awnings attached to keep out the rain during inclement weather.

Oil Worth $1,200 a Barrel

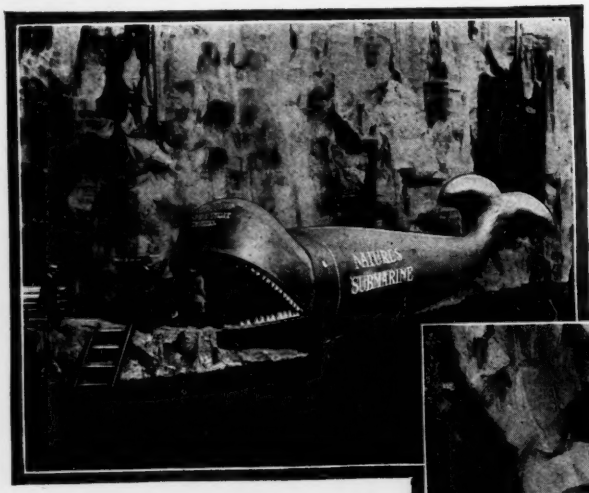
Probably the only porpoise-oil factory in the United States is that established at Hatteras Post Office, on the narrow sand strip between Pamlico Sound and the ocean, about six miles below Cape Hatteras and near Hatteras Inlet.

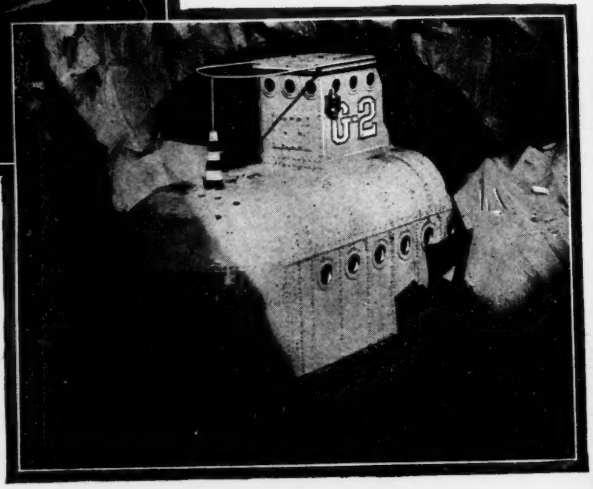
When the catches are hauled to the beach, they are killed and skinned for their hides, and the blubber is removed



Although this may seem like a box car for live stock, it is in reality a most comfortable and sanitary form of prison mounted on wheels. The "honor squad" prisoners of Atlanta, Ga., while working outdoors are using thirty-six of these cars as sleeping quarters.

from them. The hides are salted down and sent in the green state to tanneries in the North to be tanned and made into leather. Porpoise hide is used for shoe strings, for pocket books, and for various other purposes. The oil from the blubber is tried out at the factory on the beach, and then sent to New England for refining if found of sufficient value.





Photos Copyrighted International News Service

A most realistic trip in a submarine is one of the attractions of the Panama-Pacific Exposition's Zone, or amusement concession district. After a trip in the submarine the passengers are landed and guided through mysterious caves. A huge whale is one of the features of the attraction.

The head oil, valuable because it is used for oiling watches and other delicate machinery, is obtained from the marrow of the porpoise's lower jawbone, and from a small quantity of blubber found between the snout and the blowhole. In the manufacture of the oil this blubber and the marrow are mixed. The production of head oil may range from half a pint to a quart from one porpoise. Refined porpoise oil for jewelers' use is worth from $900 to $1,200 a barrel.

The body oil obtained from a porpoise amounts, generally speaking, to thirteen or fourteen gallons. To produce a barrel there is required the oil taken from about four porpoises. This oil, which is employed for various purposes, brings far less than the head oil.

Taking an Imaginary Submarine Trip at the Panama-Pacific Exposition

Exhibitors in the "Joy Zone," the amusement district of the Panama-Pacific Exposition, have spent fortunes in devising new methods of amusing the public.

One of the most novel of the many attractions that line both sides of the "Joy Zone" is "The Submarine," an exhibit which offers to its patrons an illusory under-water excursion in a boat to view the equally illusory mysteries of an illusory Sargossa Sea, Blue Grotto of Capri, submerged icebergs, and Davy Jones' Locker.

The imitation submarine, when it has received its complement of fifty passengers, is ceremoniously made airtight. It lurches forward and thus apparently starts on its under-water trip. On "arriving" at "Nature's Labyrinths," the submarine lands, and the visitors, accompanied by guides, start on a tour of the passages, which honeycomb the concession. One of the many novelties of the stroll consists in walking through the bowels of a papier-maché whale. It is obvious that the "submarine" remains stationary while the scenery moves by.

Use Your Motorcycle or Auto Tires as Life Preservers

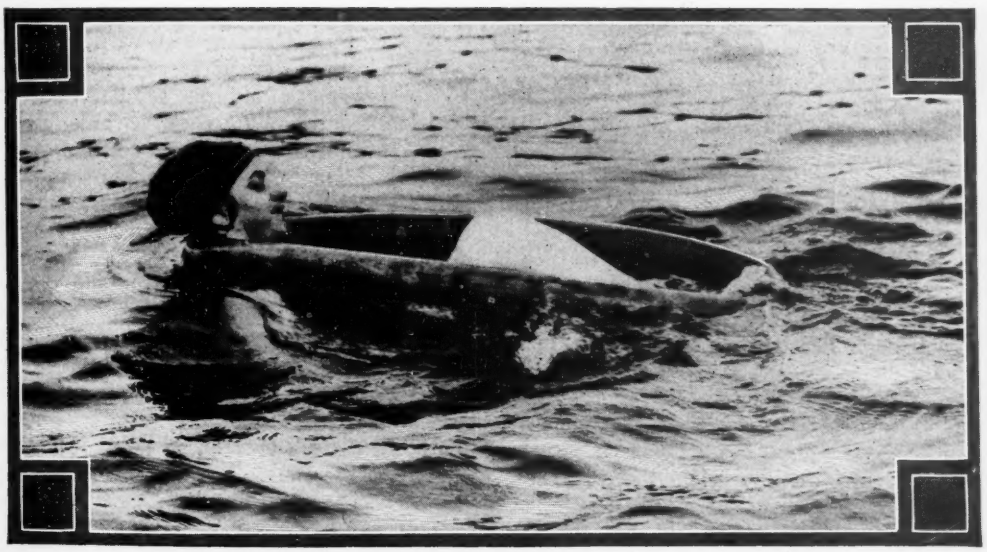
Two young English girls have recently been giving many interesting experiments at Westcliffe-on-Sea, England, to show the value of an automobile tire as a life preserver. They affirm that the buoyancy of an ordinary tire is much greater than that of life preservers, and is so flexible that it allows of the limbs being used for any swimming stroke. The accompanying illustration shows one of these girls resting after a long swim. She is supported by the tire as comfortably as though she were reclining in a hammock.

Minimizing Eyestrain at the Movies

Although makers of motion-picture apparatus are busily seeking a means to eliminate the fatiguing flicker which many patrons of the movies find so trying to the eyes, nevertheless some ocular discomfort still makes itself felt even in motion picture houses of the most modern kind.

For this reason, the optical device seen in the illustration is designed for the use of picture playgoers whose eyes are sensitive to the flicker of the films. It consists of a lorgnette-like piece of stiff black paper, with a bridge made to fit the nose of the wearer. Each eyepiece contains a narrow slit, about 1/20th of an inch wide. The size of the slit can

To eliminate the eye strain due to the flickering of motion pictures, an inventor has recently devised this simple contrivance.



Automobile or motorcycle tires make excellent life preservers. Not only do they possess great buoyancy, but their size and shape make possible the full freedom of the limbs.

be varied simply by two movable shutters to suit the vision of the individual using the instrument. The shutters can be raised or lowered over the slit. When this device is held before the eyes by means of a pivoted lorgnette handle, the effect of the narrow slits is to cut down the amount and intensity of the light rays which enter the eyes, and thus prevent the eyestrain which the flicker usually causes.

We would call it a motor-skate; the inventor calls it a mon-auto. At any rate, it is a cross between an exaggerated skate driven by a gasoline engine and a diminutive motorcycle.

At a recent dinner party given by prominent society people of Toledo, a novel feature was introduced. Each guest cooked his own dinner by electricity.

An electrical device has recently been patented by which the number of passengers entering a street car is automatically recorded. This device may obviate the necessity for the old-time fare registers.

A Forty-Five Pound Miniature Motorcycle

A sensation was recently caused in the streets of Baltimore by the sight of a man being rapidly propelled through the traffic upon the smallest motorcycle ever built. The seat of this tiny machine was little higher than the seat of an ordinary chair. A one cylinder motor furnished plenty of power, and when the driver drew up in front of his residence he picked his machine up in one hand and carried it into the house.

Hugo C. Gibson, of New York, the inventor of this new departure in the automobile field, became known to the public when he exhibited his "motor skate" at last year's automobile shows. His new machine, the "Mon Auto," much resembles the motor skate, except that it is larger and allows the rider to sit down. The rider sits on a saddle supported on the rear end of a cantilever spring, and places his feet on two rests, one on each side of the front wheel forks. He steers by a novel handlebar arrangement to which the motor control is attached in such a manner that pushing the handle forward increases the speed, while pulling it back decreases it.

The Mon Auto is 48 inches long, 9 inches wide, 18 inches high and weighs 45 pounds. Oil and gasoline for 75 miles are carried in the tubular steel frame,

and the handlebars and frame fold up to permit of easy carrying and storage.

A 2½-horsepower motor, geared in the ratio of 5 to 1, drives the Mon Auto at a maximum speed of 25 miles an hour.

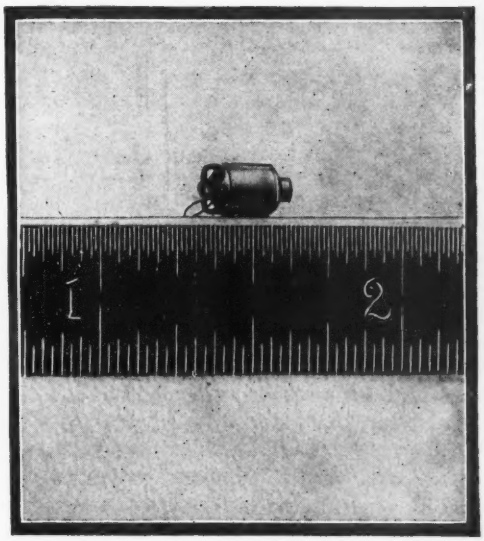
Mr. Gibson claims that his invention should be extremely valuable for military purposes. The car weighs less than a soldier's ordinary equipment and can easily be carried over fences, streams and ordinary obstructions. It offers quick and cheap transportation, while its cost must necessarily bring it within the reach of the multitudes.

The Smallest Motor in the World

Ivan T. Nedland, of Hillsboro, N. D., deserves a medal for painstaking labor. He has made a tiny dynamo, weighing but five and a half grains, probably the smallest in the world.

The length of the motor over all is 19/64 inch. The height is 11/64 inch. The commutator has four segments of gold, each segment insulated with mica. Fibre is used as an insulator between the commutator and shaft, and between the end pieces and commutator. The commutator is built as it is on large machines; no glue or cement was used in its construction. The diameter of the commutator is .0045 inch. It is mounted on a pivot steel shaft, .009 inch in diameter.

The armature has four poles, and is wound with silk-covered wire. Between the armature and the yoke are two field coils. The brushes are of silver and are but .0012 inch in diameter. The springs for the brushes are .004 inch in diameter.

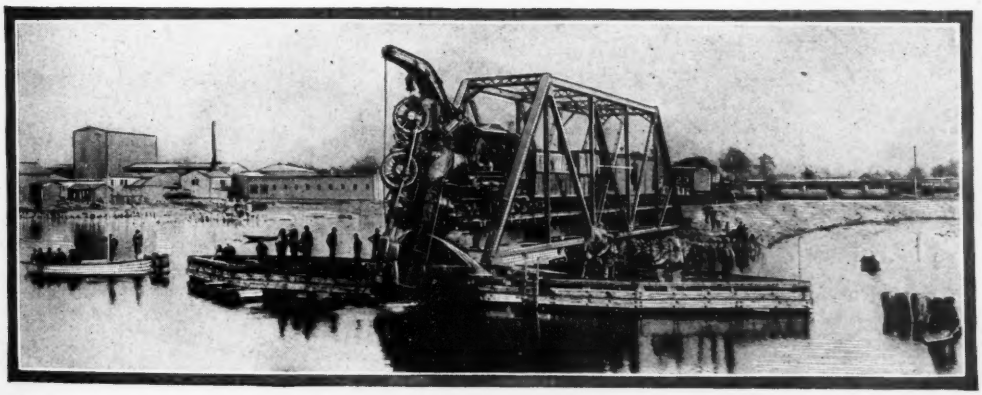


Here is the latest claimant to the title, "The smallest electric motor in the world." Have you ever seen a smaller one?

Fishing a Ten Thousand Dollar Locomotive Out of a Lake

It can be statistically proved that the safest place in the world is in a Pullman car and the most dangerous, your own home.

Only once in a while something goes



The locomotive was valued at $10,000, so the railroad officials figured that it was worth while to recover it from the bottom of the river. Divers were sent down to inspect the engine and fasten the wire cables to it. A wrecking crane soon lifted the locomotive onto the bridge and placed it gently on the rails.

wrong on the best regulated roads. The locomotive shown in the picture ran off the bridge and plunged into the river at Bay City, Michigan—one of these "once in a while" occurrences.

To-day all railroads have as part of their equipment cranes, known as "wreckers" and regularly employed in construction work of the heavier kind, such as bridge building and handling turn tables. These cranes are always ready to be rushed to the scene of an accident. Equipped with a set of tools designed to handle derailed or damaged cars and locomotives, they lift an overturned car and place it back on the rails or else carry it to the shops for repairs.

As soon as the accident pictured occurred at Bay City, a wrecking crane was sent for. It was found that the seventy-five ton locomotive lay in deep water and that it would be necessary to send divers down to attach the lines. After the divers had inspected the locomotive they came up and selected the tools they desired to use, comprising different kinds of wire rope slings, hooks, eyes, clevises, hoist beams and yokes.

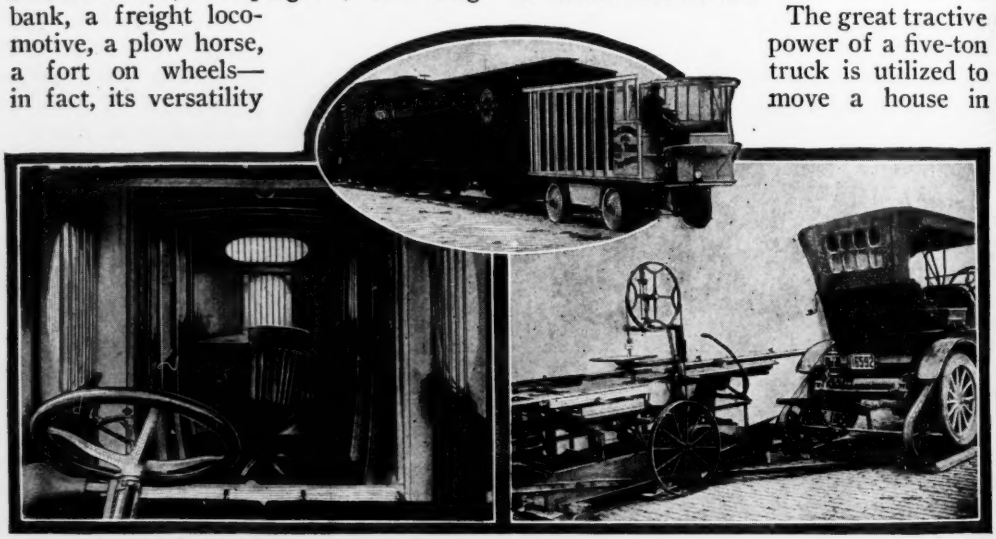
Then they went down and attached the slings and lines to the locomotive. In three hours the submerged locomotive was once more on the rails and very little the worse for the experience. Getting it out of the water so promptly saved it from damage by rust or prolonged contact with the river bottom.

Marconi is said to have invented an apparatus to destroy aeroplanes by paralyzing their motors wirelessly. The details are not yet known to the public.

NEW TASKS FOR THE AUTOMOBILE

THE motor car of today is not only a pleasure car or a truck, but it is a house-mover, a sleeping car, a traveling bank, a freight locomotive, a plow horse, a fort on wheels—in fact, its versatility would have surprised even the most imaginative of inventors in the early days of motor locomotion.

The great tractive power of a five-ton truck is utilized to move a house in



Below: The interior of the City of Detroit paymaster's car. The car body is of steel to insure the huge sums of money carried against theft. In the oval: A motor truck doing duty as shunting locomotive. At the right: Not only is this automobile used for pleasure purposes, but during working hours its owner uses it to drive a complete woodworking equipment.

Above: A complete camping equipment which is carried in an automobile. The car also furnishes electric light at night. In the circle: Moving a house by means of a motor truck.

Above: A touring car fitted with a hammock so that its occupants can spend their nights in comfortable sleep without the necessity of putting up at expensive inns or hotels.

a single working day by a Los Angeles house mover. Using a 1,000-foot cable, a block and tackle, and a convenient telegraph pole, the powerful motor pulls a house on its support of heavy iron wheels about as fast as a man can walk.

A most comfortable and complete "sleeping car" is the invention of a Westerner. The seats of a touring car are arranged so that they may be made into a comfortable berth, the bedding of which is carried in a compact roll on the running board. By means of a tent, a dining room and kitchen may be added to the complete and compact apartment.

The traveling bank is now a familiar sight on the streets of many of our large cities. The City of Detroit employs an efficient example of this type of car to pay gangs of laborers in outlying sections of the city. The body is of steel, and is proof against "hold-ups." The interior is fitted as a cashier's office, with desk and swivel-chair, filing cabinet and safe. The pay envelopes are disbursed through a barred window in the rear, where the workmen line up to receive their wages. This car has been found extremely economical, for it handles the great amount of work more expeditiously and requires less time than did the former system.

A Western concern dispenses with the use of a switch engine for shunting freight cars about upon the spur connecting its factory with the main line. It was found that a string of seven freight cars, loaded with heavy metal work, could be easily pulled by a five-ton truck just as efficiently and much more cheaply than could the heavy and cumbrous switch engine. The truck has not only been doing all of the work, but has also been in almost continuous service for general duty.

The Carefully Made Champagne Bottle

The champagne bottle must, in all its parts, be constructed of an almost mathematically even and heavy thickness. Its glass must be perfectly smooth and unaffected by the acids contained in the wine. Its neck must be exact in every particular, to insure perfect corking, and with no grain or projecting points on the inside.

Such progress has, within the last ten or fifteen years, been made in the manufacture of these bottles, that, where formerly a breakage of five per cent. was deemed small, at the present time the breakage does not exceed one per cent. Despite the perfection as to strength reached in the production of champagne bottles, the strain upon them

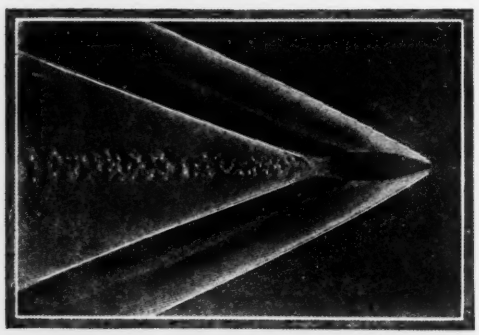
caused by the intense pressure they sustain and the repeated handling they undergo weakens them to such an extent that it is considered unsafe to use the bottles a second time.

With the exception of smaller houses making the cheaper brands, champagne manufacturing firms place their wine in none but entirely new bottles. The American Consul at Rheims reports that four glass-blowing establishments in that city, and several others in the vicinity, make bottles almost exclusively for champagne. They work night and day, in three shifts of eight hours each, and turn out about 40,000,000 bottles annually.

Photographing a Bullet in Flight

The first successful photographs of the flight of shot were made by Ernst Mach in 1885, according to Prof. Dr. F. Neesen in *Umschau.*

A point of utmost importance in understanding the flight of shot is a knowledge of the condition of the air, for the resistance of the air robs the shot of the greater part of its energy. Mach made use of the fact that light is deflected in varying degree by masses of air of varying density. Thus it became possible to note the difference in the density of the air surrounding the shot. The eye can see this distinction in the wavering currents of air that rise over a hot steam radiator, but is not quick enough to see it in experiments with shot. But the camera can see it.



A bullet traveling through the air displaces the air in much the same manner as a ship plying through water. A bow wave is formed in front of the bullet, while in its wake are waves and bubbles caused by the partial vacuum formed.

What the camera sees the accompanying pictures reveal. A bullet in the air produces about the same effect as a submarine boat in water. In front is a strong bow wave, caused by the compression of the air, and behind the projectile is a rarified space in which strong eddies arise.

Another view of a rifle bullet passing through the air at high speed.

The bow wave is actually a wave and not compressed air carried along by the shot and spilled laterally.

If a resisting body is placed at the spot passed by the shot that is taken on the plate, the picture shows the way in which the shot pierces this body or blows it up. Such photographic studies are of great value in judging the effect of shot. For example, explosive effects which formerly were believed to arise from the use of dum-dum bullets have been explained by these photographic experiments.

A Space Saving Table

One of the most congested districts in New York City is that known as Chelsea. Here a day nursery has been established by the municipality, so that children of tubercular parents may be cared for during the day. The children are given plenty of fresh, wholesome food and are kept in the best of condition. The nursery became so crowded that at meal times it was necessary to feed the children in two shifts, and, needless to say, the ones who had to wait did not like it. The supervising nurse finally solved the problem simply and ingeniously. She had the centers cut out of the low, round tables at which the children are seated. Now they all eat at the same time, the very little ones have the

inside seats and the older children the outside, and there is an air of general satisfaction in the nursery.

The suggestion offered in this article might well be followed by anyone confronted by the same problem as the supervising nurse in this case. Since the entire surface of a table is seldom necessary, why not cut out the center?

In this day nursery space is at a premium. Using an ordinary table it was found necessary to serve the children in two shifts, which was both impracticable and resulted in dissatisfaction among the youngsters. The supervising nurse finally hit upon the idea of cutting away the center portion of the table, so that children could sit both around and inside the table thus formed.

How Ammonia Is Made

A great many unthought of processes lie back of the average article in common use. A great deal more is involved in the making of a piece of ice, for instance, than the machinery and process of the ice plant. One of the things essential to ice-production is ammonia. The manufacture of this cold-producing chemical is no less interesting than the making of the ice itself.

Most commercial ammonia is a by-product of gas manufacture. When the coal is placed in the retort at the gas plant two products result from its disintegration. One is the gas which is piped to our homes and used. The other is a liquid which contains a strong percentage of ammonia.

This liquid is placed in vessels in which it is allowed to stand and settle. This brings the liquid portion to the exclusive occupation of the upper level, the solid substance having settled to the bottom. The free ammonia is driven from the liquid by steam. A mixture of lime with the contents of the vessel serves to separate the fixed ammonia, and this is then driven to itself by another application of steam.

The steam collects the ammonia and gases and, together with them, it is

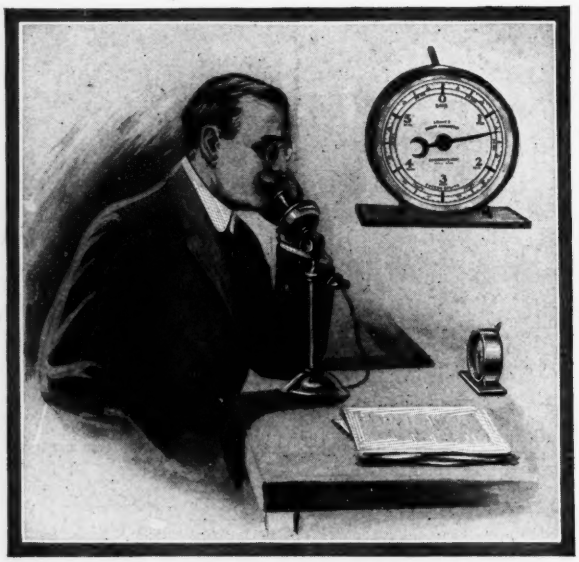
forced through leaden tanks containing sulphuric acid. In this the ammonia takes the crystal or sulphate form, and may be removed from the tanks by means of ladles. The ammonia not taking the crystallized form is gathered in water, from which is made the liquid ammonia or hartshorn in common use.

Free ammonia is not found in Nature and must therefore be produced by artificial means. There are other methods of manufacture, but the one here described is probably the only one in any large use.

Ammonia, of course, has many uses other than household use and ice-manufacture. It is largely used in dyeing, calico-printing, making coloring substances, and in chemical compounds.

Measuring Telephone Talk

A new device, designed to aid a person to gauge carefully the time spent in a long-distance telephone conversation, has been invented not for the benefit of the telephone company, but for the benefit of telephone conversationalists. The makers of this instrument claim that toll calls average less than two minutes per call, and that since three minutes of conversation are paid for, more than $60,000,000 is paid yearly for toll service that is not rendered.



Long distance telephone conversation is expensive. In order that a business man may converse to the full limit of one call this talk-measurer has been introduced.

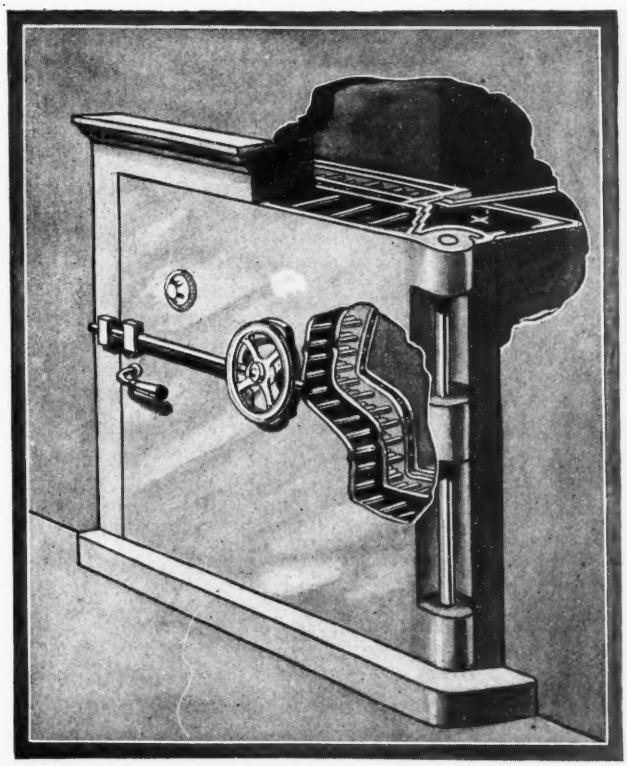
The talk-measurer is a small clock built on the principle of a stop-watch. The dial is marked off into minutes and their divisions, and the total revolution of the hand occupies six minutes. The three-minute mark is emphasized by the announcement in red letters, "Excess begins." When the connection is made between the speakers, a lever is moved, and the clock starts to record the time. As soon as the conversation is completed, the clock is stopped. The time consumed by the call is thus accurately registered, to be noted for reference in case of overcharge by the telephone company.

Rendering a Bank Safe Burglar Proof

A most dangerous weapon in the hands of safe "crackers" is the oxy-acetylene blowpipe, by which the hardest steel is consumed like butter. This process seems to meet the desires of the safe burglars better than any other. So it is not surprising that a few years after its invention the fusing burner was adopted as a burglar's tool. The first time it was used by burglars was in April, 1907, in the robbery of a bank in Antwerp.

The rooms of the Antwerp bank were on the ground floor of a hotel in which the thieves rented a room directly over that containing the bank's safe. Their "baggage" consisted of a complete apparatus for generating acetylene, two cylinders of compressed oxygen, a blowpipe torch and other necessary tools. On a holiday, when no one was in the bank, they sawed a large, square hole in the flooring of their room and with the aid of a rope ladder entered the part of the bank containing the safe. First they hung two thick blankets on the two sides of the safe, thus forming a kind of tent, to prevent the bright flame from being seen

outside. They then put on automobile glasses to protect their eyes from the powerful light and went to work. In a few hours the thieves had melted out the piece of heavy plate containing the lock, drawn back the bolts, and opened the safe. The booty gained was over 25,000, it is said.



Lined with concrete and provided with a clever construction of bolts, this type of safe is claimed to be as proof against burglars as any type yet devised.

At first there seemed to be no protection against the fierce heat of the oxygen flame. Safemakers tried various chemical fillings behind the exterior plate to generate poisonous or explosive gases as soon as the smallest opening is made. Packings were also devised, so compounded that their gases would extinguish the flame of the burner. One manufacturer proposed the use of a thick paste that hardens in the air and instantly stops up the hole. There are also safes that have a plate of copper in back of the exterior plate. The current of oxygen striking it causes the copper to be covered with an incombustible copper oxide, thus making it difficult to reach the inner walls of the safe. There are drawbacks, however, to all these methods of prevention. The copper plate can be pierced with relative ease by a drill and chisel. Moreover, poisonous gases give no absolute protection, as there are devices for overcoming these poisons, such as the smoke helmet and devices for inhaling oxygen.

A new armor-plate steel has lately been invented at the Krupp plant in Germany which is practically unmeltable as a safe-steel on account of the great amount of time and gas necessary for its fusing. This new invention is not extensively employed as yet, so that more interest at present attaches to another method of protection that has been adopted of late years. In this method the safe is so made that it is impossible to reach the bolts of the lock. These doors consist of five steel plates, set one behind the other, and bound together by powerful steel bolts. The bolts are screwed from behind into the exterior plate and are distributed over its entire surface at short intervals. In this arrangement a short bolt always stands between each set of two long ones, so that the heads of the bolts are arranged alternately behind the intermediate plate and the covering plate. The space between the plates is filled with cement to cover the bolts entirely. Behind the heads of the bolts and firmly united with the frame of the doors are the steel plates, which make it impossible to drive the bolts through to the interior. It would take a burglar more than a whole night to open this safe, and it would require more gas than can be compressed in the pair of tanks that a burglar would carry.

Fighting the Menace of Shifting Sands

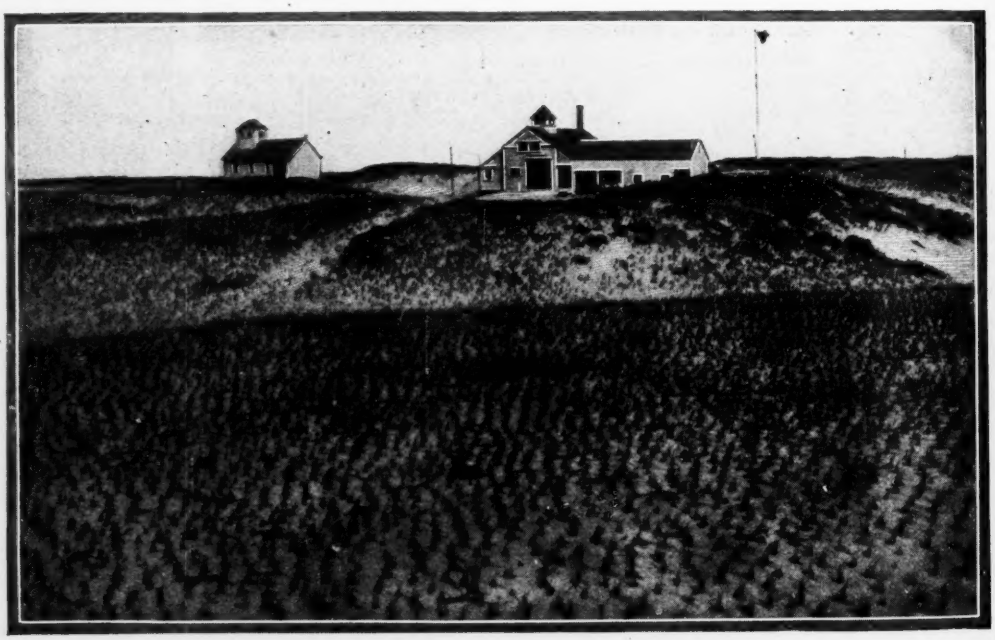
By William S. Birge, M. D.

VAST tracts of land are annually inundated by sand drifts. What the blizzard, the cloudburst and the tornado are to cities high winds and storms are to the seashore and other sandy stretches. Great sand drifts bury railroad tracks and sweep over farms. Sand dunes appear where yesterday was a plain.

Nature has provided an ample remedy for her own curse in the form of certain grasses that grow in sandy wastes. Wherever they are found the sand is held together. It is possible to select and transplant these grasses so that the most stubborn and lawless beach may be held in control. By their aid the people of Holland have finally secured their hard-earned country against the constant efforts of the North Sea to devour it; and after a constant struggle of nearly a hundred years France has transformed the desolate shores of Gascony into fertile fields and forest lands.

The Government at Washington has for many years, through the Department of Agriculture, conducted an investigation regarding the nature of sand grasses. It has learned what other countries have accomplished with them and has brought from all lands hundreds of specimens representing every known variety not grown wild in this country. It has experimented with them under all possible conditions and made trial plantings in the sandy wastes along the shores of Washington, California and Florida.

These extensive investigations do not stop with the mere binding of the sand along the coasts. In the eastern portion of Oregon and Washington, and in other sections of the interior, are large areas so sandy as to be of little or no value. In some places the soil consists of pure sand, the shifting of which has devastated miles of arable lands, buried trees and destroyed whole forests. In the vicinity of Provincetown, Cape Cod, is what is known as the "buried forest,"



The planting of sand grass has done much to prevent the shifting of sand which, in many instances, proves disastrous. Not only does sand grass serve this all-important function, but, it is claimed, the productiveness of the sand is also improved.

called so because the tops of scrub pines are just being visible on the surface of the dunes.

The two most important sand-binding grasses are the *marram*, or beach grass, and the *sea lyme*. Another grass which is useful as a binder and which is found on the Atlantic coast south of the range common to the marram and lyme, is called "little panic grass." Growing in the sands along the western coast of America is a species of Poa, which has been called seaside blue grass by the Bureau of Agriculture. But the most promising of all the grasses so far discovered by the bureau, and one only recently obtained is called the sand blue grass. It is a native of the interior, appearing in the arid places of the South and West, and it serves as forage where the more nourishing grasses will not grow.

The fact that sand-binding grasses may be developed having nutritive qualities shows to what extent the experiments have been carried by the Agricultural Department. It has also been proven by the bureau that pure sand, if planted with these, may become transformed into a more productive soil.

THE RETURN OF NATURAL INDIGO—ONE EFFECT OF THE WAR

GERMAN chemical science, about twenty years ago, killed an important agricultural industry—raising the indigo plant for its dye. The industry was not small. It was measured by many millions of dollars, and it produced among the planters of India many so-called indigo nabobs. China devoted large acreage to the plant. A century ago Louisiana tried to raise the plant, only to find that sugar cane paid better.

The manufacture of this fine blue dye, so essential to the world, tempted the research chemists of Germany. For thirty years they spent much money and effort trying to make real indigo in the laboratory. Some methods were devised, but they were too expensive. It was not until about twenty years ago that success was achieved. Naphthalene (the substance of which so-called "camphor balls" are in part composed), an almost worthless by-product from the distillation of coal tar, was used as the starting point. The accidental breaking of a glass tube threw some mercury into an experimental vat and caused a successful reaction not before obtained. Quick appreciation of what had happened gave the chemist the key to the problem, and artificial indigo, equal to the best natural, was made more cheaply than before. The planters were driven from the field, figuratively speaking, and now twenty million dollars worth of artificial indigo is sold every year. The Hindus and Chinese turned their indigo acreage into grain fields sadly needed in such famine-stricken countries. So this chemical triumph was a blessing to the world.

About four hundred tons of the dye were exported from India last year, but five years ago the amount was double this. Last autumn the war prevented exportation from Germany of the artificial product, and the price rose 500 or 600 per cent., thus tempting the Hindu planter to increased acreage for the present season. Some large producers are said to be in London negotiating with the British government for a guarantee against loss in the future if they attempt to put the natural industry on its old basis. This strikes a popular note in the present state of the British mind on the subject of German dyestuffs.

Even China has decided that the six and a half million dollars it pays Germany every year for synthetic indigo might be spent to better advantage at home. The war has cut off much of the importation. This means some privation to the Chinese, who have always been extremely fond of indigo blue.

A Land Yacht and Its Transcontinental Voyage

"The Gypsy Van," perhaps the largest and most completely equipped motor car in the world, is now on its way across the continent with a passenger list of eight persons, as well as a crew of three, who are provided with as comfortable eating, sleeping and living accommodations as are to be found in most small yachts.

This yacht on wheels is over 25 feet long—a greater length, in fact, than the familiar Fifth avenue 'buses. It is 7½ feet wide, 13½ feet high, and weighs between seven and eight tons.

There are sleeping accommodations for eight persons inside the body of the car, while the roof may be enclosed so as to form a chamber for the two chauffeurs and the cook.

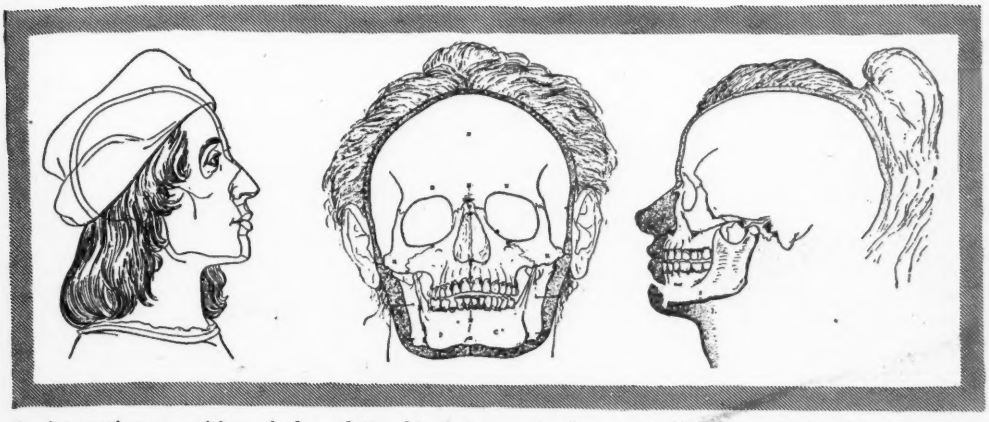
Electricity, supplied by a generator, lights the interior of the car and operates an electric range in the well-equipped kitchen. Food supplies sufficient to last a week may be carried in cupboards and in an ice-chest which has a capacity of 100 pounds of ice, in addition to storage room for perishable foods.

The "Gypsy Van"—perhaps the largest and most completely equipped motor car in the world—which is now on its way across the North American continent. It has accommodations for eight passengers and a crew of three.

Above: The interior of the "Gypsy Van", with the kitchen in the background. In the Circle: Front view of the huge motor car. At the left: The land yacht under way.

A six-cylinder motor of about 60 horsepower is used, and with the special transmission which has been installed it is expected that this gigantic van will be as flexible under bad road conditions as a pleasure car. There are nine speeds forward and three reverse. The gear ratio of the lowest speed is 6 2/3 to 1, and that of the highest is 8 2/3 to 1. The brakes are exceedingly powerful; the service brake acting on the rear wheel having a friction surface of 260 square inches.

Before starting from New York the car was given a thorough try-out over rough roads and proved equal to its task.



An interesting exposition of the relationship between the human skull and its flesh. Scientists have made such a careful and exacting study of this relationship that they can reconstruct a face from almost any skull.

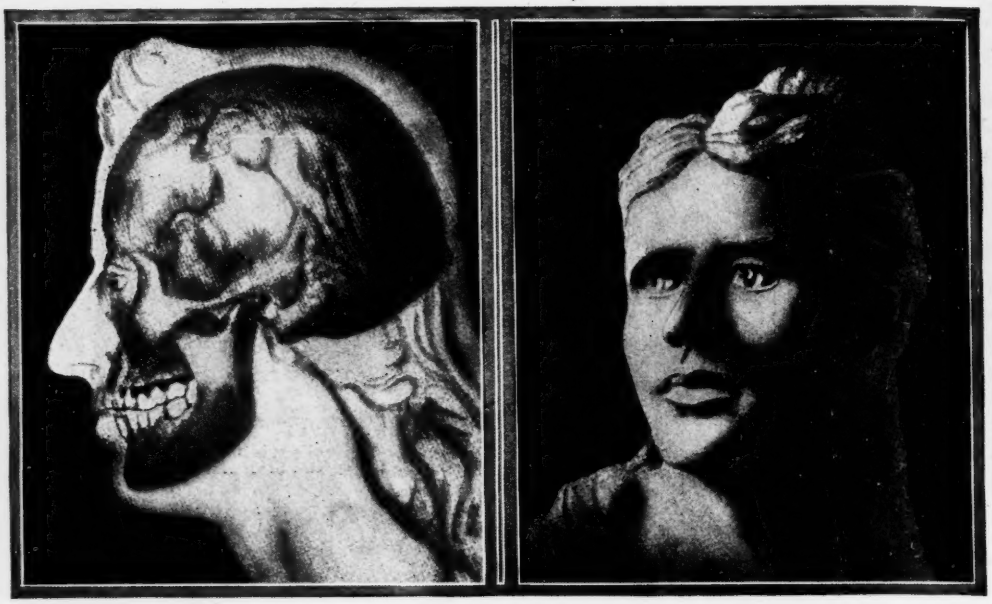
Reconstructing Facial Features from the Skull

WHEN Shakespeare, in his impressive and uncanny Gravedigger Scene, causes Hamlet to recognize one of the skulls as having belonged to Yorick, the dead jester, he may have merely been providing his audience with a fantastic, over-imaginative thriller. But in the last century the scientist anatomist has undertaken the almost impossible task of demonstrating that all human skulls possess sufficient points of difference to enable him to reconstruct, by means of portraits and death-masks, an actual likeness of the face of the individual who during his lifetime proudly bore the skull on his shoulders. To the layman, in fact, all human skeletons and skulls appear to be hopelessly similar; indeed, it is only in real life that we can distinguish, thanks to differences in facial characteristics, one person from another. But science has succeeded in reconstructing the human face with nothing but the skull and a portrait or a death-mask to furnish the clues.

The inspiration for this fascinating work of reconstructing the human face occurred as the result of a famous controversy over the skull of Schiller, the German poet. Upon his death, his body had been immured with twenty-two others in a vault in the cemetery at Weimar, Saxony. When, in 1826, this vault had to be emptied, the coffins were so completely decayed that Schiller's could not be recognized from the others. Accordingly, a comparison was then made between the twenty-three skulls and the only known death-mask of Schiller; and in the unanimous opinion of a large body of so-called experts, the largest skull was decided to be Schiller's.

Upon the subsequent discovery, however, of a second death-mask at Weimar, the German anatomist, Welcker, compared both masks with the supposed skull of Schiller, and made the startling announcement that there was no resemblance between it and either mask; consequently it could not be the skull of Schiller. His views, of course, were not widely accepted, and caused a long and fruitless controversy between 1884 and 1887. Twenty-five years later, Prof. von Froriep found another skull in the vault, which he maintains is the genuine Schiller skull. He made profile drawings of this skull and of the mask, and fitted them together. He obtained the exact thickness of the fleshy parts of the face from a large number of measurements of suitable corpses; and his conclusions are now accepted as valid and beyond dispute.

By a similar method, the genuineness and authenticity of the skulls of the artist Raphael, and of the musicians



A phantom view of the skull of the prehistoric woman of Auvernier and the probable flesh covering which it had. At the right is the modeled face of the woman.

Haydn and Bach, have been successfully and completely settled.

When no portrait or death-mask of a person exists, the face is reconstructed by a different method. Such was the problem presented by a well-preserved skull found in a prehistoric pile dwelling in 1878 at Auvernier, near the Neuenberg Lake. From its appearance, it was evidently that of a woman about thirty years old, who had lived in the bronze or stone age, 7000 or 8000 years ago. In order to reconstruct a likeness of this prehistoric relic of the white race, it was necessary to ascertain the normal thickness of the flesh in various parts of the face. This was determined by a series of very careful measurements of the faces of eight female corpses. A very fine needle, with graduations of 1/100th of an inch, was used in these measurements. After many tiny plaster pyramids were erected all over the skull to correspond with the data, they were connected with a layer of clay, the surface of which was flush with their tops. The result was a rough clay reconstruction of the face, which was completed by an artist named Buechly, whose skill and imagination supplied the hair and neck to complete the famous lifelike bust of the Woman of Auvernier.

A Mobile Motion Picture Studio

A complete travelling power plant, installed on a high-powered motor car, and able to furnish light for outdoor motion picture photography, is the latest addition to the equipment of the Lubin Company. This mobile power plant is equipped with a powerful generator, connected with a switchboard to which many different circuits may be run for the successful illumination of an outdoor scene. A thirteen-inch navy searchlight, with a capacity of 4,500,000 candlepower, mounted upon the car, makes one think of the pictures of the great searchlight cars with the armies in Europe. The entire plant and automobile weighs approximately eight thousand pounds. Compactness and simplicity of the plant was the principal aim in designing the unit. It is said that remarkably successful night effects have been produced with the aid of the machine.

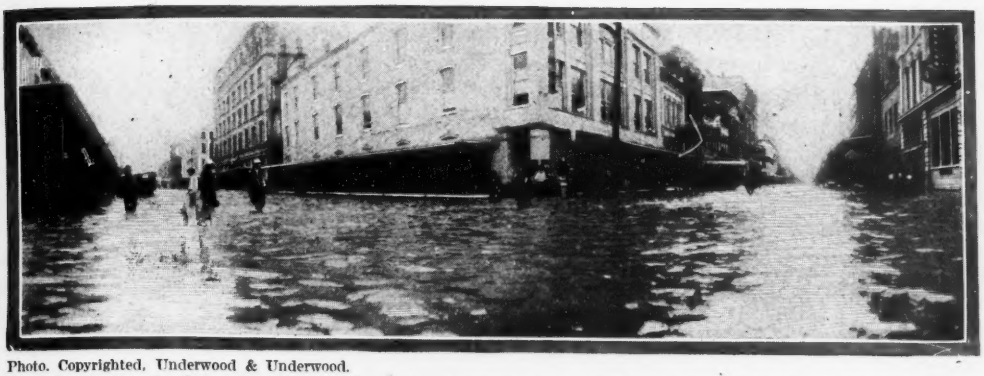


Photo. Copyrighted, Underwood & Underwood.

A typical scene in Galveston during the flood following in the wake of the hurricane. This conveys an impression of the conditions in the business section of the city.

The Latest Galveston Hurricane

IT should be said at the outset that Galveston enjoyed no monopoly of the tropical storm that raged at that place August 16-17, 1915, and there is no more justification for calling it the "Galveston hurricane" than for calling it the "Haitian hurricane," since this identical atmospheric disturbance did immense damage in the island of Haiti. In naming a storm of this character we are confronted with the same difficulty that the historian will have to solve when he undertakes to name the battles of the present European war, some of which have involved fighting along a front of hundreds of miles.

Like the ever-memorable "Galveston hurricane" of September, 1900, the recent storm spent some days in traveling across the Caribbean Sea and the Gulf of Mexico before it reached our southern coasts. It was a true West Indian hurricane. Storms of this type are extremely violent whirls in the atmosphere, in which the surface winds blow in a direction contrary to that of the hands of a clock; not in a circle, but spirally inward toward the center. The storm as a whole, which covers an area never more than a few hundred miles in diameter, travels rather slowly along a path which, in the typical case, runs at first a little north of west, and at about latitude 30 degrees recurves toward the

Photo. Copyrighted, Underwood & Underwood

A few of the many homes that were wrecked by the hurricane at Galveston. The preliminary estimate of the loss of property, made by the Government, placed it at $15,000,000.

Photo. Copyrighted, Underwood & Underwood.

The wreck of a vessel that was blown inland by the violence of the wind. In the background may be seen a portion of the great seawall which has done much to prevent the recent hurricane from causing greater loss of life and property.

north and northeast. In the great majority of cases the recurving occurs so far to the east that the storm does not enter the Gulf of Mexico, but sweeps northeastward off the Atlantic coast. The storm of August, 1915, however, like the one of 1900, traveled across the Gulf, and the low-lying coast districts of the Gulf states were devastated by the storm waves, more damage being done by water than by wind.

During the hurricane season the United States Weather Bureau receives daily cable reports from a number of meteorological stations in the West Indies, and also wireless weather reports from steamers plying West Indian waters. The recent hurricane was first sighted August 10, when reports from Barbados and Dominica showed a fall in the barometer of .14 inch in 24 hours; an occurrence that, in tropical latitudes, means trouble. The storm center was then probably somewhere between Martinique and St. Vincent, in both of which islands wind and water wrought some mischief, especially to shipping.

On the morning of the 11th the disturbance was apparently central to the southward of St. Croix, and moving a little north of west. No damage was reported in the Danish islands, but heavy northeast gales were raging over Porto Rico. Twenty-four hours later the center of the storm lay just south of Haiti, and widespread destruction was reported in the southern part of that republic, including some loss of life. Between the morning of the 12th and the morning of the 13th the hurricane passed over the island of Jamaica, where damage amounting, it is said, to about $10,000,000 was done; the banana crop suffering most severely. During the next twenty-four hours the storm passed directly over the extreme west end of Cuba, where, among its other exploits, it destroyed the wireless station at Cape San Antonio. By the morning of the 15th it had passed over Yucatan Channel and was apparently central a little north of Yucatan Peninsula, moving more to the north of west than previously.

The peril that now threatened the Gulf coast of the United States was unmistakable, and every effort was made by the Weather Bureau to distribute warnings wherever they were needed. In following the progress of the storm across the Gulf the Bureau relied to a great extent upon the reports received by radiotelegraphy from shipmasters, and this comparatively novel method of keeping track of hurricanes again proved its great utility. On the morning of the 16th the storm was supposed to be central about 3½ degrees south of the Louisiana coast, and during the night of the 16th-17th it reached the coast of Texas, a short distance south of Galveston. Here the barometer fell to 28.53 inches, and the wind reached a maximum velocity of 90 miles an hour. (In 1900 the barometer fell to 28.48 inches, which was lower by .10 inch than any reading

Photo. Copyrighted, Underwood & Underwood.

A group of huts on the beach which have been wrecked by the high winds.

previously recorded in the United States, and the wind is supposed to have been blowing at 100 miles an hour (when the Weather Bureau anemometer was carried away.)

Galveston and its vicinity had ample notice of the storm's approach, and precautions were taken accordingly. Mr. W. P. Stewart, in charge of the Weather Bureau station, sent men on motorcycles over the whole of the island, thirty miles in length, on which the city is situated, warning people that they would certainly be drowned unless they came into town immediately. Hundreds of lives were saved, due to this commendable precaution.

Photo. Copyrighted, International News Service.

Piles of wreckage strewing the beach at Galveston after the passage of the earthquake.

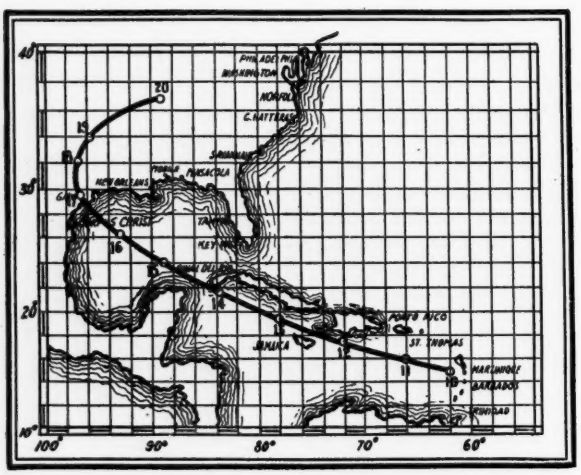
The city itself was spared a repetition of the tremendous disaster of 1900, in which some 6,000 persons perished, chiefly because of the remarkable engineering works which have been carried out for its protection by an enterprising municipality. The storms of 1900 and 1915 probably did not differ much in force or character. In each case huge waves were generated, partly by the difference of barometric pressure between the center and the periphery of the storm and partly by the force of the wind. The "storm wave" is a characteristic feature of a tropical cyclone, and such waves, when they inundate low-lying coasts, are often responsible for appalling disasters. Not to mention those that have devastated the coast of India, costing, on occasions, hundreds of thousands of lives, the Texas coast has frequently suffered from such waves.

After the catastrophe of 1900 the city of Galveston erected a seawall of steel-reinforced concrete, 17 feet high, 16 feet wide at the base, and 5 feet wide at the summit, along the whole front of the city. It has a concave face which is protected by a riprap of huge granite blocks. This wall has now passed through its first severe test successfully, on the whole, though about a thousand feet of it was battered down, and the people of Galveston may henceforth feel themselves tolerably secure from the fury of the waves.

Another engineering enterprise carried out in consequence of the 1900 disaster was the building of a two-mile reinforced concrete causeway connecting Galveston Island with the mainland. Part of this was carried away in the recent storm. The most striking, how-

ever, of the precautionary measures adopted by the people of Galveston was the raising of the grade of their city to a maximum of 19 feet above its previous level. The whole city — houses, car lines, walks, etc.—was raised on stilts, while 20,000,000 cubic feet of sand, dredged from the Gulf, was pumped in, after which the whole was consolidated and restored to its normal condition at the new level. This achievement was almost without precedent.

These three engineering feats, together with timely warnings of the approaching storm, explain why only about 14 lives were lost at Galveston. Considerably more than 100 persons are supposed to have perished at other places. At Texas City, on the short of Galveston Bay, a camp of 7,000 soldiers of the United States Army was wiped out by the storm. Ten soldiers lost their lives and many more were injured.



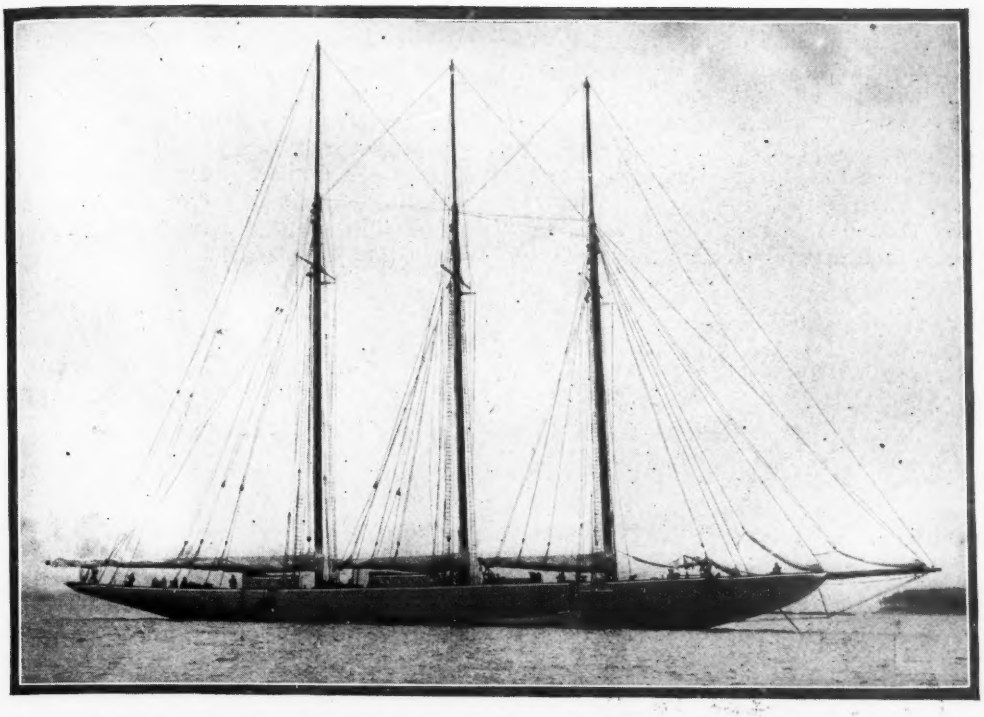
A map of the region visited by the Galveston hurricane, showing its position on various dates.

Galveston was not, however, saved from severe material damage; most buildings along the water front were wrecked, great havoc was wrought among the shipping, and several fires occurred after the storm had broken the water mains leading to the city's supply wells on the mainland. A preliminary estimate places the property loss in Galveston at $15,000,000, as compared with $20,000,000 to $30,000,000 in the storm of 1900. It is impossible, at this writing, to estimate the total loss in the area visited by the storm. About 25 per cent. of the central Texas cotton crop is said to have been destroyed, and there was great damage in the oil fields.

On the morning of the 17th the storm was central to the southwest of Houston, where at 2.30 A. M. the barometer (reduced to sea-level) read 28.21 inches—a reading probably without precedent in this country—and the wind blew 80 miles an hour. During the 17th, however, the storm diminished in force and continued to recurve, so that by the morning of the 19th it was central over extreme northeastern Texas, and was accompanied by torrential rains. General floods occurred on the rivers of the southwest. On the morning of the 20th the center was over southeastern Missouri, and heavy rains and gales still prevailed. Incidentally, St. Louis experienced a rainfall of 7 inches during the 24 hours ending 8 P. M. of the 20th, flooding the lower parts of the city and interfering with steam and electric traffic. On the same day the Mississippi rose rapidly and flood warnings were issued.

Three days after Galveston was swept, the disturbance moved eastward, south of the Great Lakes, and ceased to be a "storm," in the ordinary sense of the term, as the furious winds that leveled buildings and plantations in the West Indies and heaped mountains of water against the sea-wall at Galveston gave place to moderate breezes. The meteorologist will tell you that it was just as much a "cyclone" as ever, but it ceased some days before to be a "hurricane."

To avoid the use of unclean towels at public washstands, there has recently been invented a device by which a person's hands are dried by heated air.



The "Sea Call," claimed to be the largest and finest schooner yacht afloat at the time she was launched, was in the water barely six weeks when the corrosion of the skeleton and plates, due to electrolytic action, made the vessel practically worthless. As a result the ship has been ordered broken up for junk. The destructive agent, electrolytic action, resulted from the use of monel metal and steel together.

How Electrolytic Action Destroyed a Yacht

THE *Sea Call,* a few weeks ago the largest and finest schooner yacht afloat, is now being broken up for junk after being used by her owner, Alexander S. Cochran, for only six weeks. Heralded throughout the yachting world as the fastest cruising yacht ever built, the *Sea Call* is now the center of a heated controversy between scientists, ship designers and technical writers.

The *Sea Call* was an experiment in ship design. She was the first steel ship ever built with a bottom made entirely of monel metal, although this metal, which is composed of two-thirds nickel, one-third copper and a small percentage of other metals, has been extensively used about ships for deck fittings, anchors and other parts.

Mr. Cochran's yacht had been in the water less than six weeks when it was discovered that portions of the steel skeleton and plates around the stem and stern had been so seriously corroded by electrolytic action that it was feared the ship would go entirely to pieces within another month. As a result of this, the magnificent ship was ordered broken up for junk.

Monel metal, when placed in conjunction with steel in salt water, starts an electrolytic action much like that existing in an electric battery. One of the metals becomes a positive element, while the other assumes a negative polarity; the salt water forming the electrolyte or exciting solution. In this action the steel is slowly corroded and in a short time loses its tensile strength.

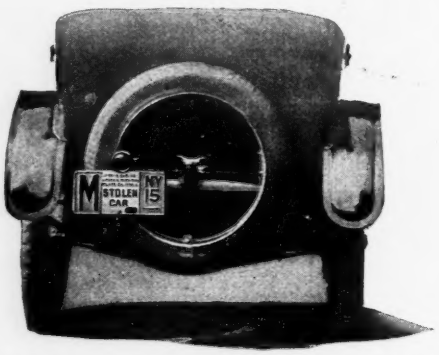
Electrolytic action has been noticed before under somewhat similar circumstances, but has never caused the wide-

spread interest that has been occasioned by the faulty hull of the *Sea Call*. The Pennsylvania Railroad, in experimenting with monel metal, placed a propeller upon their towboat *Overbrook*, which was composed of two steel blades and two monel metal blades mounted upon an iron hub. After three years' service it was found that the monel metal had been unaffected but that the steel had been somewhat corroded.

The United States Navy has used monel metal somewhat extensively, but when it was placed in conjunction with steel under water a piece of zinc was incorporated in the construction. The electrolytic action attacks the softer metal, zinc, and tends to neutralize action on the steel. The naval authorities are greatly interested in the *Sea Call*.

A Sign that Renders Your Car Proof Against Theft

An automobile tag, claimed to be the most efficient device yet put on the market for the purpose of preventing the theft of cars, has recently been offered to the public by a Philadelphia concern. It is a metal plate that can be locked over the license tag and bears the startling inscription, "If this car is driven with this plate on, it is a stolen car."



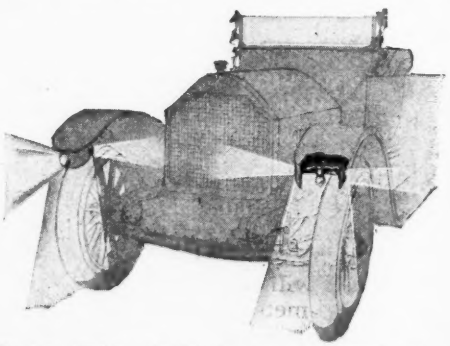
No better protection against theft could be had than this simple plate which is placed over the usual license tag.

The plate is simply a device for covering the license number of the car with a bright colored plate bearing words which are sure to attract attention. The intending thief cannot remove the tag without breaking the lock or using a skeleton key. This device has met with great favor among the insurance companies which issue burglar and theft insurance policies for automobiles. One company has ordered 100,000 plates and is making them a feature of its policy.

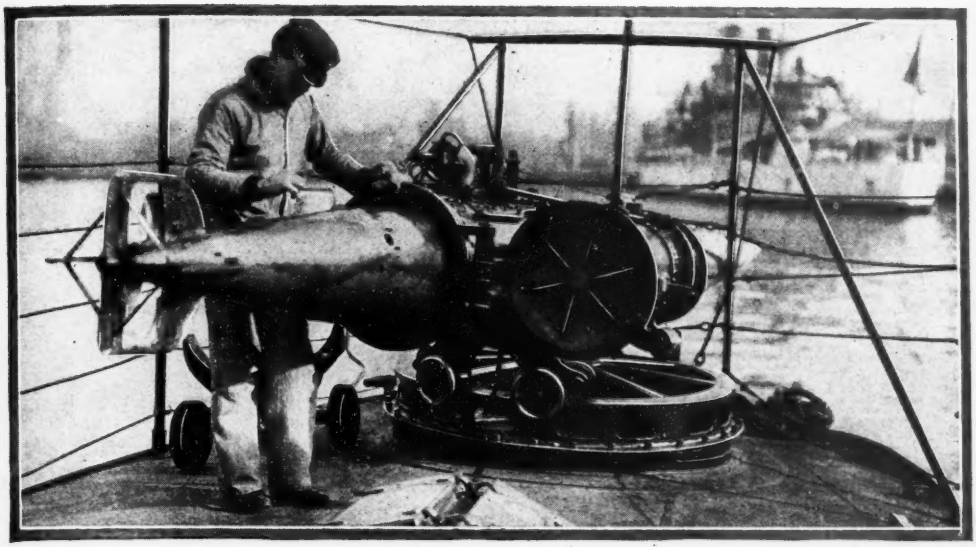
Mudguard Lights to Show the Width of an Automobile

A new system for illuminating automobiles has recently been patented by Edmund D. Shaw, of Syracuse, N. Y. At the present time, most cars are lighted by searchlights between the mudguards or by side lights near the driver's seat. Mr. Shaw believes that many of the accidents occurring while cars are passing on a dark road are caused by an improper arrangement of the lighting system, the drivers not being able to judge the length and width of the oncoming car properly.

To obviate this trouble, the inventor has placed a small light on the front of each mudguard. Holes are made in the front and sides so that when the dazzling searchlights are turned out, an approaching driver can see the exact width of the car. As he is passing, the light on the side of the nearer mudguard shows him just how near he is to the other car at all times, and the two cars are able to pass on a narrow road without accident.



Electric lights placed in the mudguards of an automobile are found of great value in avoiding collisions at night on dark roads.



Torpedoes are launched from the decks of torpedo boats and cruisers by means of adjustable, gun-like tubes known as launching tubes. The torpedo is placed in the breech of the tube and the gate closed. A puff of compressed air admitted into the chamber in back of the torpedo ejects it into the water.

Providing a Torpedo with Ears

By Edward F. Chandler

THE *author of this article is a recognized authority on torpedo construction. He assisted Capt. Leon in working out the sound-control torpedo, described in this article, and he has had much practical experience in the construction of the Whitehead torpedoes used in the United States Navy. As the inventor of a new gyroscopically-controlled torpedo his work has attracted the attention of the United States Government and foreign governments. The following article may therefore be considered an authoritative exposition of a very ingenious type of weapon.*

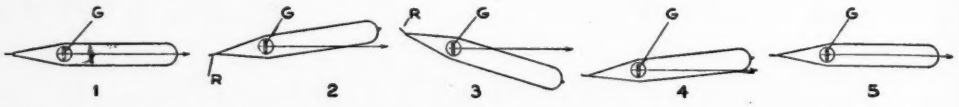
—EDITOR.

AS a piece of mechanism the torpedo is probably the deadliest and certainly the costliest weapon of modern warfare. In its cruelest modern European form it carries about 400 pounds of gun cotton in its "war head," and it costs about $7,000. If it once hits a ship, either total paralysis or complete destruction is sure to follow.

But what makes it hit its mark? Remember that this deadly contrivance must travel through the water for a distance of at least half a mile if discharged from a submarine boat, and a distance of from five to seven miles if launched from a battleship during an engagement. What keeps this $7,000 worth of death on its course?

To answer that question we must first find out something about the construction of a torpedo. Imagine a cylinder twenty-one feet long (the size of the latest United States model), in the nose of which a charge of guncotton is contained; imagine behind the charge a compartment containing air at a pressure of a ton to the square inch; imagine in back of this air tank a compressed

air turbine and propellers—imagine all this and you have before you the vitals of a torpedo—all but its brain.



Bringing a Torpedo Automatically Back on Its Course

THIS conventional diagram represents several positions of a torpedo as it would appear at different points along its course. In each of the views G represents the gyroscope, the gyroscopic axis being indicated by the long arrow, which points in the general direction of the torpedo's travel. In view 1 the torpedo is parallel with its gyroscopic axis and traveling in a straight line. In 2 the torpedo is turning to the left; consequently the rudder R has been swung slightly to the right, due to the fact that the center line of the torpedo is not coincident with the gyroscopic axis, as shown.

The rudder having been turned to the right, the torpedo is steered back across its course, and in position 3 it has passed the meridian on the other side; consequently the rudder is corrected to the left, which again carries the torpedo back across the meridian, as shown in position 4. At position 5 the torpedo is virtually back on its gyroscopic line.

In this country it has been the practice to employ a steering mechanism in which the rudder is swung definitely in a hard-over position either to the right or to the left with no neutral or center stop. This causes the torpedo to steer a crooked course. Since the rudder is provided with very little throw, the weapon deviates but slightly from its impressed direction.

The Mechanical Brain of the Torpedo

A mechanical brain of some kind is obviously necessary; for this death-dealing torpedo of ours must be guided automatically upon its course and must never swerve very far from it. Some way must be found to keep it at a set depth and to prevent it from swerving to the right or to the left.

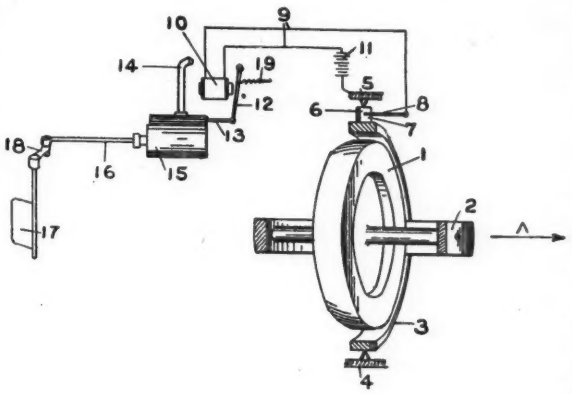
The ocean itself, paradoxically enough, holds the weapon at a fixed depth. Every one knows that the pressure of water increases as you near the bottom. If it were not so divers could perform even more difficult feats than now lie within their powers. The water is allowed to press against a diaphragm on one side; against the diaphragm on the other side a spring pushes. It is obvious that by adjusting the tension of the spring a perfect balance can be maintained between the sea water on one side of the diaphragm and the spring on the other. Connect the diaphragm with horizontal rudders and you have an automatic depth regulating gear. If the torpedo should dive below the set distance, the pressure of the water on the diaphragm would overcome the spring; the rudders would be thrown down and the torpedo would rise until spring tension and water pressure were absolutely counterbalanced. The opposite effect occurs when the torpedo is traveling too high and the spring tension is greater than that of the water pressure.

The Wonderful Gyroscope—A Never-Failing Compass

To prevent the torpedo from swerving to the right or to the left the gyroscope is employed—the most puzzling, the most mysterious device in the whole realm of mechanics. A gyroscope, generally speaking, is any rapidly rotating body. A spinning top is a gyroscope. So is a rapidly turning flywheel. It is one of the properties of a swiftly turning wheel that it resists any attempt to throw it out of its plane of rotation. It is this property of a gyroscope which is applied in automatically keeping the torpedo on its course.

Now the gyroscope of a torpedo consists simply of a small, heavy flywheel, mounted so that it may freely revolve in a frame which is in turn pivoted in what is known as a gimbal ring. In other words, the wheel can swing around

both horizontally and vertically. Before the torpedo is launched the frame carrying the flywheel is locked, so that the wheel itself is held in a fore and aft position in the torpedo. While it is thus locked the wheel is spun at high speed. When released it will hold its plane of rotation even though the torpedo may be swung around horizontally, so long as the spinning continues. By connecting rudder with the gyroscope, the torpedo by the very act of departing to the right or to the left, will swing them and thus bring itself back again to the predetermined course. If the torpedo curves to the right, the rudder moves to the left; if the torpedo starts off to the left, the rudder shifts over to the right. The torpedo always travels along the line passing through the plane of the gyroscope's rotation, and the plane or rotation always lies along the line which the torpedo is supposed to take — the line in which the torpedo is pointing at the instant the spinning wheel is set free. It is wonderful, indeed to think that a little spinning wheel keeps a torpedo on its course.



How the Gyroscope of a Torpedo Works

IN the drawing, 1 is a fly wheel, and 2 the frame carrying the fly wheel, half of which has been removed to expose the wheel. This frame is pivoted in a horizontal plane in the ring 3, which has also been broken away, as shown. Ring 3, which carries the fly wheel in the frame 2, is pivoted at 4 and 5 in the vertical plane in a suitable support or frame. It is evident that the gyroscope fly wheel 1 is not only free to revolve about its axis, but also to swing around its vertical and horizontal pivots.

For the convenience of illustration 6 represents an insulated member carried by the ring 3, and having a contact surface 7. Resting against the contact surface is a brush 8, which is connected in circuit 9 with an electro-magnet 10 and a battery 11. In the picture the current is on and the magnet energized; in consequence the armature 12 is drawn over. The armature carries a balanced valve 13, which controls the flow of compressed air through the pipe 14 to the turbo-motor 15. The piston rod 16, of the turbo-motor, also acts as the rudder rod for the horizontal-course steering-rudder 17, on the post of which is a crank 18.

When the gyroscope swings around so that the insulated portion 6 is carried under the brush 8, contact is broken and the electro-magnet 10 de-energized. The spring 19 then instantly pulls the armature 12 and consequently the valve 13 to the opposite extreme position, thus causing the rudder 17 to shift over. The arrow A represents the general direction in which the torpedo is supposed to be traveling, it being understood that the gyroscopic fly wheel 1 is revolving at high speed.

How a Torpedo Is Launched

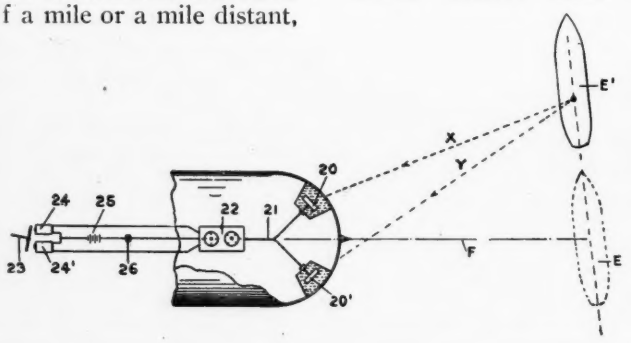
A torpedo is discharged from what is known as a launching tube by a puff of compressed air. At the top of the torpedo is a little latch, which is tripped as the torpedo passes out of the launching tube, so as to cause the compressed air to operate a little engine which spins the torpedo. The air is automatically cut off and the gyroscope released when a sufficient speed of rotation has been attained. Compressed air is also supplied to the propelling engine of the torpedo at the same time. All this must happen during the fraction of the second required for launching.

It is evident that a torpedo is nothing but a little ship, traveling through the water at railway speed, guided by a mechanical helmsman, and kept on its course by an automatic compass — its gyroscope. Surely it would be difficult to imagine anything more mechanically intelligent. Unlike most human beings, a torpedo is absolutely obedient; it does exactly what it is told.

Perfect as this

mechanism seems to be, nevertheless, it has its defects. It is not quite modern enough. Launch it from a submarine at a battleship a half a mile or a mile distant, and it will perform its task with ghastly perfection. But launch it at a dreadnaught seven miles away — and this is the range at which modern sea battles are fought — and it is doubtful if it will ever find its mark. Why? Firstly, because it is hard to hit a moving target at long range, if not actually impossible; secondly, the gyroscope gradually "dies" down like a boy's top which has spun too long. Once the speed of the spinning flywheel drops below a certain critical point the torpedo no longer keeps upon its course. Unfortunately this slowing up of the gyroscope occurs just when the torpedo should be most trustworthy; just when it must adhere most surely to its course — in a word, at the moment of striking.

Other factors must also be considered. The speed and direction of the vessel which fires the torpedo must be considered, so must the distance to be covered, the time allotted to reach the target, and the target's speed and direction. Fire point blank at a battleship only three miles away and the torpedo will miss its mark; for by the time the 35-knot weapon covers the intervening distance the ship will be many yards beyond the point at which the torpedo was intended to inflict its destruction. Clearly, the torpedo must be shot ahead of its mark, and it must be so timed that the two will inevitably meet. It is so difficult to make all these calculations that long-range torpedo fir-

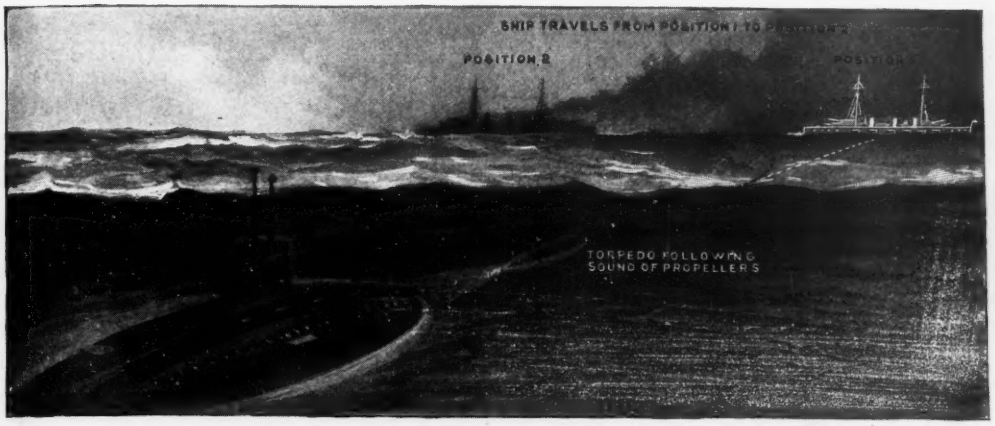


The Ears of the Leon Electrical Torpedo and How They Hear a Hostile Ship

THIS is a schematic diagram of the apparatus invented by Captain Leon to control torpedoes by enabling them literally to hear the propellers of a hostile ship. The "ears" or sound responsive devices 20 and 20¹ (microphones) are enclosed in a suitable casing located within the head of the torpedo and surrounded by a sound-transmitting medium, such as water or gelatine. The sound passes directly through the shell of the metal head, which is about one-sixteenth of an inch thick.

The two microphones are connected by an electrical conductor 21 with an adjustable device 22. The rudder 23 is here shown directly controlled by the magnets 24 and 24', which are electrically connected with the adjustable controlling device 22 to receive energy from a battery 25 when the switch 26 is automatically thrown into operation. This switch 26 forms part of a clock work mechanism which throws out the gyroscope control and connects the sound control, after the torpedo has traveled within the range of the sound vibrations sent out by the propellers of the enemy. It is important that the torpedo should not turn upon its own ship in response to the beating propellers. Hence the torpedo is made to travel under gyroscopic control for a certain distance, before the "ears" are allowed to operate.

To illustrate the operation of this apparatus, let E represent the position of the enemy when the torpedo is originally discharged and F the intended line of fire. Had the torpedo continued as originally intended it would have missed its mark, the enemy having proceeded in the meantime to the position E'. As soon as the sound device is released for operation by the clock switch 26, vibrations are conveyed to the torpedo along the lines X and Y. Rays traveling along the line X strike the microphone 20 squarely, whereas microphone 20¹ is out of the zone of influence. Clearly, the microphones are out of balance; one "ear" is hearing more than the other. The magnet 24 is therefore energized, and the rudder 23 is automatically turned in the position shown, thus causing the torpedo to be steered around toward the enemy. When the torpedo is headed for the enemy and consequently both microphones are equally energized, the rudder assumes a midship position.



How the Leon Torpedo Hears an Enemy's Propellers and Directs Its Course Accordingly.

THE straight dotted line represents the intended course of the torpedo as it was dispatched originally against the enemy. The enemy has passed beyond the path of the torpedo; but, thanks to its microphones or ears, the torpedo alters its course as shown by the dotted line and overtakes the enemy in its new position on a curved path.

ing is much less dangerous than is commonly supposed.

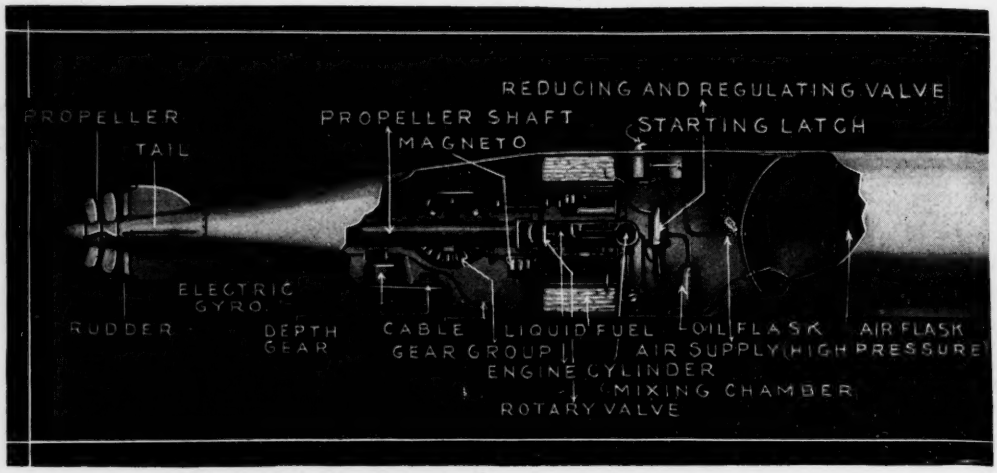
Because battle ranges are now so great that the gyroscope cannot be expected to keep up its spin for a corresponding period, we find Nikola Tesla, Rear Admiral Bradley A. Fiske and John Hays Hammond, Jr., trying to control torpedoes by wireless. But a much more startling plan than theirs is that of Captain Karl O. Leon of the Swedish Navy. He would have an enemy's ship destroy itself by attracting a torpedo to its very side.

His invention consists in giving a torpedo ears—electrical ears which will enable it to hear the propellers of a ship and direct itself toward the sound. Only a ship at anchor would be safe; for in the murkiest weather or the darkest night his torpedo will hear the propeller vibrations and head for them.

The Electrical "Ears" and How They Hear

Captain Leon's electrical ears are microphones. A microphone is found in every telephone transmitter. It is an instrument for intensifying feeble sounds, or for transmitting sounds, and it is based on the principle that the transition between loosely joined electric conductors decreases in proportion as they are pressed together. The conductors form part of a circuit through which a current is passing, and the variations in pressure due to sound waves in the vicinity of the conductors produce variations of resistance, and hence fluctuations of the current, so that the sounds are reproduced in a telephone receiver. In the modern telephone the transmitter is essentially a microphone, the pressure of the sound waves being communicated to the conductors by means of a diaphragm.

Captain Leon mounts four of these sensitive electrical ears on a torpedo. When they are influenced by the sounds of the enemy's screws they automatically steer the torpedo, not at the direct source of sound (the propellers), but several yards to the right or left, according to the direction in which the hostile ship is traveling. The four sensitive ears are in the head of the torpedo and point forward. Two of them are located on the horizontal center line and two on the vertical. The right and left microphones on the horizontal center line control the horizontal steering rud-



The Shonnard Torpedo—

THIS drawing shows schematically the application of the Leon steering device to a modern long-range high-speed alcohol propelled submarine torpedo invented by H. W. Shonnard. In the fore part of the torpedo head can be seen the starboard microphone receiver. In the upper part of the head is located a box in which the adjusting mechanism is contained, the purpose of which is so to regulate the microphone as to cause the weapon to strike either to the right or to the left of the source of sound. An electric cable extends from this controlling box through the air flask to the gyroscopic gear located in the after body. The gyroscopic gear is connected with the rudders as described in the article and diagrammatically shown on page 491.

The Shonnard torpedo is perhaps the most promising type of internal combustion propelled torpedo which has yet appeared upon the horizon of American practice, and it is here illustrated in conjunction with the Leon microphone steering device because of its extreme novelty of design. It will be noted that the propellers are driven by three horizontal engines, one of the cylinders being located above and two below the center line of the torpedo, thus ensuring stability and providing a very compact and powerful motor. Around the engine is an enclosed space in which the liquid fuel (alcohol) is carried.

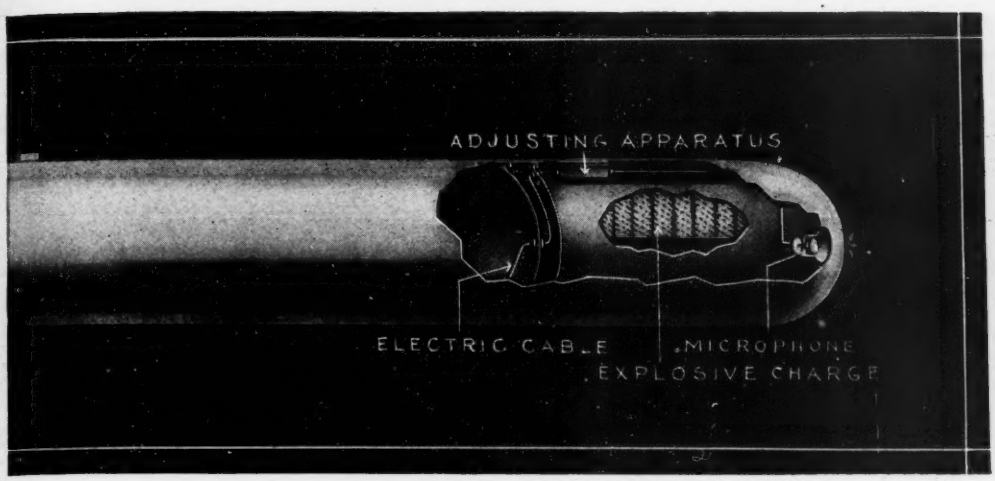
ders, and the upper and lower microphones on the vertical line control the depth steering mechanism.

Preventing the Torpedo from Blowing Up Its Own Ship

Captain Leon also employs a gyroscope, but it serves to guide the torpedo only for a short distance. As soon as the electrical ears hear the propellers the gyroscope is thrown out of action automatically and the ears left to themselves. Of course, the vessel which fires the torpedo also has propellers. It is very important that the torpedo shall not hear them, turn back on its course and blow up its own ship. For that reason a suitable clockwork time switch is introduced which keeps the sound apparatus from operating until the torpedo has proceeded a considerable distance on its deadly errand.

If the Leon torpedo is correctly pointed toward the enemy, an equal amount of sound reaches each one of the microphones or ears; but if, for instance, the weapon is traveling too far to the right or to the left the effect on one ear is greater than it is on the other. Consequently, the rudder is caused to shift and the torpedo's course is altered until the microphones are all equally influenced by the vibrations set up in the water. After that the torpedo proceeds head on.

Sound travels much more quickly and clearly in water than it does in air. That is one reason why the propellers of a large battleship will set up a disturbance



The Latest Fashion in Torpedoes

Compressed air from the air flask passes through a reducing valve and is delivered to the engine at a uniform pressure. The liquid fuel is maintained under pressure derived from the air flask and is delivered to the mixing chamber.

The propeller shafts are tubular and are telescoped one within the other. They are revolved in opposite directions by a group of three gears directly driven by the engines. An extension on the end of the main propeller shaft revolves within a casing and performs the function of a rotary valve, the head of which forms one-half of the mixing chamber. The ignition system has, of course, the usual spark plug and magneto.

From an oil flask oil is delivered under pressure to the valve chamber, where it serves the double purpose of lubricating and preventing leaks.

When the starting latch on top of the torpedo is tripped, which happens when the torpedo is launched, compressed air is admitted to the engine in order to start it. At the proper instant a suitable charge of alcohol is sprayed into the mixing valve and exploded into the cylinder. Shonnard employs a tank of compressed air so as to relieve the engine of the necessity of compressing the charge in the manner familiar to every automobilist.

in the water which would influence delicate microphonic receivers over a very great distance. Even though the torpedo may be several thousand yards out of its course, it must inevitably be drawn toward its prey.

The Ultra-Range Gyroscope and Its Possibilities

Originally Capt. Leon did not include a gyroscopic steering gear, but depended solely upon the sound-receiving microphones for steering. This arrangement is unsatisfactory except for very short distances, because the weapon is liable to make a large detour before the sound apparatus comes into play. The introduction of the gyroscope was a decided improvement and greatly increased the efficiency of the weapon.

By using the ultra-range gyroscope invented by the author it is possible to increase the efficiency of the Leon torpedo almost 100 per cent. The extreme accuracy which is made possible by this new form of gyroscope greatly reduces the demands made upon the sound receiving apparatus. In actual practice it is necessary to employ only two sound receivers, one on the right side and one on the left, in order to maintain a horizontally steered course.

Guiding the Torpedo by Means of an Echo

The Leon torpedo, it has been pointed out, is effective only against a moving ship. Why not send out a call from the torpedo and let the ear be guided by the

echo? In order to make the torpedo effective even against an anchored vessed, the author has conducted experiments which lead him to believe that an oscillator or sound producer may be inserted in the nose of the torpedo for the purpose of sending out sound vibrations which may be reflected by an anchored ship. There is good reason to believe that the effect of the reflected sound is practically the same as that of the direct vibrations, except that over great distances they are somewhat enfeebled. But the results thus far obtained are encouraging to such an extent that it will ultimately be possible to use the Leon torpedo even when a ship's propellers are not working.

The torpedo tube of an American submarine boat. The pivoted lid is opened at the moment the torpedo is to be ejected.

Capt. Leon is not the only inventor who has been working in this field. Christian Berger of Hungary and John Gardner of England have independently suggested the use of microphones on a torpedo. It was their idea to place one or more microphones on a torpedo. But instead of picking up sounds emanating from a hostile vessel, they intended to send out submarine signals from a controlling station, by means of which the course of the torpedo could be governed. To this there is the manifest objection that the vessel must be seen to be guided. Although it is not necessary to provide the torpedo with high masts easily shot away (one of the difficulties of wireless control), it is nevertheless necessary to watch the course of the torpedo while it speeds toward the enemy.

THE LIGHTNING ROD COMES BACK

After a number of years of increasing unpopularity, the lighnting rod is rapidly reappearing on the roofs of houses and barns throughout the country. The statement made a great many years ago by those who were supposed to know, that lightning rods not only were ineffective as lightning preventives, but that they actually attracted lightning, has been proved to be absolutely false by an extensive series of tests made by the United States Weather Bureau. Circular letters were mailed to mutual insurance companies throughout the country, especially to those in the agricultural districts, requesting statistics concerning the fire losses of insured buildings occasioned by lightning in comparison with losses due to other causes, and particularly the fire losses occuring to buildings equipped and unequipped with lightning rods. The replies gave strong evidence of the value of the rods. In 1912 and 1913 about 200 mutual insurance companies doing a business of fully $300,000,000 had 1,845 buildings struck by lightning. Of this number only 67 were equipped with lightning rods. So far as could be learned about 31 per cent of the buildings insured by these companies were rodded; hence, if the rods had furnished no protection, buildings struck would have numberd 572 instead of 67. Thus the efficiency of the rods in actually preventing lightning strokes appears to have fully 90 per cent.

Panama Pacific Exposition Notes

AMONG the species of Argentine woods on display in the Agricultural Palace, is that known as *Quebracho Colorado,* which is worthy of mention because of its unusual qualities, which fit it especially for types of construction requiring a wood that shall withstand the attacks of the elements for a maximum of time. This Quebracho wood, resembling red-wood in color, has a density of 1.225 and weighs from 70 to 80 pounds to the cubic foot, or approximately 20 pounds more per cubic foot than live oak. It is used by all Argentine railways for ties, and is practically indestructible, even when in contact with the ground; in fact, ties which have been in use for twenty-five years are still sound and will outlast the steel rails. The wood's durability is shown by pieces of construction timber taken from a dock in Buenos Aires. The wood, though exposed to the water and elements for fifty years, is apparently as sound as it was when first driven into place.

An instructive exhibit in the California state building is that comprising working models of such apparatus as is used in the various methods of the metallurgy of gold. There is a large topographic model of a mountainous section typical of the type of country in which the hydraulic process might be employed. The delivery pipe, running down the side of the mountain, supplies water to the huge monitors, which direct powerful streams against the dirt and rock and wash them into the sluice troughs, where the gold is caught. Then there is the bumping table or concentrator, which separates the free placer gold from the lighter sand and gravel by a shaking-up process; *placer* gold being a term applied to deposits found in beds of sand, clay or gravel formed by the corrosive action of the weather upon original deposits.

The latter, in the form of veins running through the rock stratum, is termed *reef* gold, and is often separated by the amalgamation process. The gold-bearing ore is put into the stamp mill, where it is crushed and then washed over amalgamated plates (copper plates coated with mercury), where the gold is amalgamated or held back by the mercury while the quartz and other rock materials pass on in the form of tailings. The pure gold is then separated from the gold amalgam by a process of distillation. The silver, with which native gold is usually alloyed, is often recovered by this same method. Nearby is a remarkable working model of a huge Yuba gold dredge. It is about ten feet long and is operated by a number of electric motors, the current for which is controlled from a switchboard located outside of the tank in which the "dredging" operations take place. Yonder series of eight substantial safes houses the $100,000 collection of gold nuggets and gold-bearing ore, as well as a few hundred dollars' worth of diamonds and platinum nuggets, which tend to add to the attractiveness of the

whole. This is said to be the finest collection of gold in its various forms ever assembled.

The United States Army and Navy exhibits in the Palace of Machinery are probably the most popular—as they naturally would be under existing conditions—of all the displays in the main exhibit palaces. Demonstrations are given several times daily of the method of protecting harbors and inlets by means of electrically controlled mines. There is a glass tank about 20 feet long by 4 feet wide and 5 feet deep which is partly filled with water, in which floats a model of a battleship, so arranged that it may be drawn back and forth parallel to the sides of the tank by an electric motor. A number of miniature mines are anchored, by weights resting on the bottom of the tank, a few inches below the surface of the water. These mines contain several little glass windows through which the observer may view an electric lamp which represents the explosive charge. At each end of the tank is a working model of a coast defense fortification with its equipment of mortars, disappearing guns and searchlights. An explosive charge, placed in the bow of the battleship, is so connected that it may be fired by passing a current through the wires controlling the motion of the vessel. The lamps within the various mines are connected electrically with a keyboard at one of the shore fortifications, and the firing of the mine is represented by the lighting of the lamp in its interior and the explosion of the charge within the ship. The object of the demonstration is to show that any one of the mines can be fired at will; thus making them a source of danger to a foe, but harmless to an ally. A particular mine is designated and the uninitiated spectators are told to note its action when the ship passes over it as an ally. Nothing happens. The ship is next treated as a foe. The searchlights and guns of the shore fortifications immediately get into action and the ship proceeds toward the mine. Upon reaching it the lamp within lights, an explosion takes place which tears a hole in her side and blows off her stacks, and she lists to port and begins to sink. Then, when the delighted spectators have dispersed, the attendant repairs the ship and makes it ready for the next demonstration.

The type of electrically controlled mines used in "observation" firing, under actual conditions, consists of a watertight steel shell three feet in diameter and from three to seven feet in length, partly filled with explosive and containing the detonator. The mines are held in place about ten feet below the surface by cast-iron anchors weighing 2,000 pounds each. These anchors are automatic in that they automatically pay out enough cable to permit the mine to float at the required depth; thus in the planting of such an anchor it is necessary to know only the approximate depth of the water. The automatic feature consists, essentially, of a heavy weight connected with the anchor by a rope or cable of a length equal to the depth at which the mine is to float; the cable being so connected to the anchor that the reel within, paying out cable to the mine floating on the surface above, is automatically stopped when the tension on the cable carrying the weight ceases by reason of it reaching the bed of the ocean. The anchor continues to sink and, the reel within being locked, the mine is pulled below the surface to a depth equal to the length of the measuring cable. The mines are planted in groups of from 7 to 19 each, there being a distance of about 100 feet between the mines of each group, and their cables are led to a distributing box, resting on the bed of the ocean, which is in turn connected with the firing station at the shore fortification. The usual charge is 100 pounds of *trotol*, and it has been determined, by experiment, that the maximum destructive effect occurs when the explosion takes place at a distance of about seven or eight feet from the hull of the ship; the area affected at this distance being greater, and the damage of a more desirable nature, than when the explosion takes place right next to the hull. The advantages of trotol over guncotton lie in its greater destructive power and the comparative safety with which it can be handled. It cannot be detonated when the least bit

damp and hence can be handled with impunity by merely keeping it slightly moist.

There is an interesting display of various sizes and types of projectiles, some of which are shown in longitudinal section. The largest is a 16-inch cast iron shot which stands on end about 5½ feet high. It weighs 2,400 pounds and the propelling charge is 666½ pounds of smokeless powder. Near by is a large section of six-inch nickel steel armor plate which has been pierced through and through by a six-inch shot, apparently as easily as one might pierce a sheet of paper with a pencil. There is always a group of people admiring the Whitehead Automobile Torpedo and the attendant thereto is kept remarkably busy answering questions pertaining to its virtues. The periscope is another popular instrument and it amuses its admirers by enabling them to view scenery on the farther side of an adjacent wall. There is a collection of chronometers which are of particular interest to the antiquary; among which are several recovered from the battleship Maine, now rusted almost beyond recognition after their fourteen years of submersion.

HOW GERMAN BREAD LAWS INSPIRED AN INVENTOR

Laws have been passed in Germany which determine not only how much bread may be sold to any one person but when he may buy his bread—all because the country's food supply must be husbanded during the war. Curiously enough, these laws have given one German inventor a chance to enrich his day and generation with a device that every Teutonic household needs.

If there is anything that a German loves with his cup of coffee in the morning it is a crisp, hot roll. Alas, the law forbids the selling of rolls in the morning. They must be bought in the afternoon. That inspired one German with an idea. He would eat no soggy rolls of yesterday's baking. And so he invented a roll warmer which can be placed on the table.

This convenient form of heater for the morning rolls has been invented by a German as a result of the war conditions in his country.

His invention is simple enough. It consists simply of a perforated drum with a toasting plate inside. Hold the drum over an alcohol lamp for two minutes, turn it, and the roll of yesterday, inside, becomes as fresh and crisp as if it were baked an hour previously.

THE UNFAITHFUL COMPASS AND THE POLE

"True as the needle to the pole," like many another popular saying, must fall by the board. It is no longer scientifically true. In order that it may keep itself duly informed as to the unfaithfulness of the needle to the pole, or technically, the "variation of the compass" from the true north, the United States Government maintains a Division of Terrestrial Magnetism.

Not only does the magnetic needle vary at different places, but the variation changes from

year to year, and even at different times in the day. Places which, at a particular time, have the same amount of variation, are connected on magnetic-survey charts by what is known as an "isogonic," or equal-variation line. Through these points on the map in which there is no variation of the needle from the true north, a line known as the "agonic" passes.

Iron deposits and mountain ranges modify the action of the unknown causes of periodical variation, so that the corresponding lines become very crooked.

Isogonic charts may be accurate to-day and full of small errors in a few years. The famous boundary between Pennsylvania and Maryland, known as "Mason and Dixon's Line," surveyed in the years 1763 to 1767, was "run by the stars," and not by the needle. That was a great piece of foresight for its day. Had the line been surveyed by the compass in 1800, it would have shown a deviation in some places of two miles, and had it been run by uncorrected compass a hundred years later, in 1900, the variation would have reached nearly nineteen miles to the south. As a result the rich coal fields of two Maryland counties would have belonged to Pennsylvania. And yet people ask: "What's the good of science?"

The discovery of the magnetic needle's shortcomings was probably made during the voyage of Columbus. Certainly the great Genoese must have wondered at the behavior of the compass. Indeed, it is said that the needle's action spread consternation among his crew.

A NECESSARY POISON

Arsenic is not one of the things that we are apt to think we could not get along without, but according to the French scientist Gautier, its presence in the human body is absolutely necessary to some of its most important vital processes.

This terrible poison, the mere mention of which calls to mind the philters of antiquity and the fascinatingly horrible operations of the poisoners of the Middle Ages, is, it appears, neither more nor less than a constituent element of the tissues of all living beings, vegetable or animal. Without arsenic, no life is possible; a purveyor of death is one of the great supporters of life.

Arsenic, says Professor Gautier, exists normally in man and animals, in the skin and its appendages, in glands and in the brain and the bones. In the other organs it has been found only in slight traces. This organic arsenic is eliminated by the skin, the hair, and the horns in mammals.

Whence comes this arsenic? Gautier, not having found it in wheat, discovered it in such lower plants as marine algae, seaweeds and "plankton," that strange food of whales, consisting of vegetable débris, lower animal life and microscopic algae, suspended in sea-water. Sea-water, then, the great generator of the lower forms of life, is a veritable bouillon of arsenical cultures.

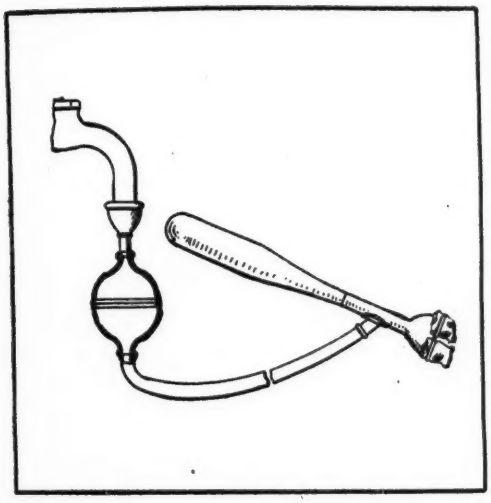
Where does the sea get this quantity of arsenic, which, taking into account the enormous mass of sea-water that covers the globe, must represent a huge weight? Only the primitive rocks that have been corroded and abraded by the sea since geologic times would seem capable of furnishing this quantity of arsenic. And, indeed, Gautier found by chemical analysis that this was so—that granite, for example, contains arsenic. The provision of arsenic on the earth's surface is, therefore, enormous, and will be sufficient for ages for the consumption of living beings, who also constantly restore it. The arsenical cycle has, it appears, thus been established by Gautier. First the sea takes it from eruptive rocks and dissolves it. Numerous marine plants, as well as fishes, absorb it, and transmit it to man. Land plants also take it from the soil formed by the débris of old rocks and pass it on to other plants and to animals.

There is now on the market an electric filter for household use in which current is only consumed as the water is being drawn through it.

Recent Novel Patents

Scrubbing Device

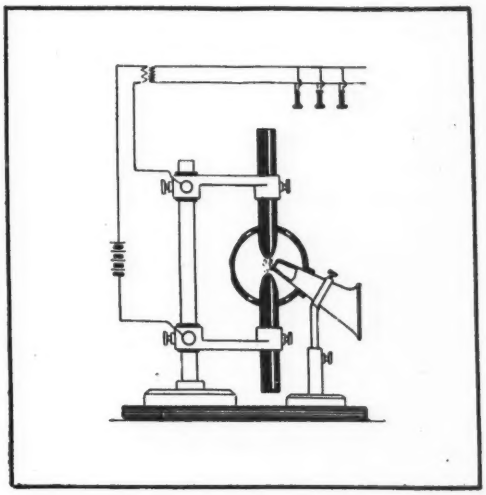
A scrubbing device that automatically feeds itself with water and soap is the boon to housewives which has recently been invented. A tube connects the scrubbing brush with a faucet through which a continual stream may run. Part way down the hose is inserted a container for soap. The water running through this container becomes suitable for scrubbing without further application of soap. At the end of the scrubber is a perforated plate over which a cloth is fastened. The



soapy water runs through the perforations and seeps into the cloth, making what is claimed to be a very useful and labor-saving device.

Sound-Transmitting System

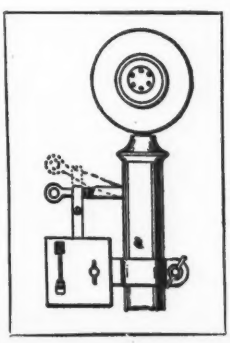
A new form of apparatus for transmitting sounds over wires to a plurality of telephone receivers is the subject of a recent patent. As will be seen by the accompanying sketch, the transmitting member of the system consists of an arc enclosed in a chamber to which is secured a horn or mouthpiece. As the sound waves pass through the horn they affect the steadiness of the arc, thus



varying the current passing through it. These variations are transmitted through an induction coil and the line wires leading to a number of telephone receivers.

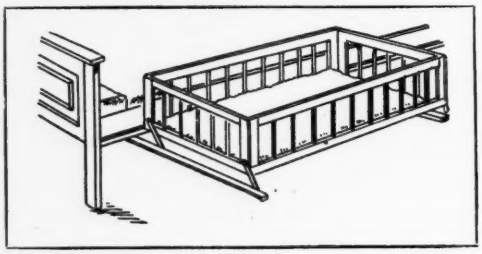
Automatic Fire-Alarm System

A simple automatic fire alarm that is connected with the lever of an ordinary telephone instrument has recently been put on the market. The device is so adjusted as to hold the hook lever of the telephone receiver in the same position as it occupies when the receiver is hanging in its place. If a fire starts, the heat melts a fusible link and starts a spring mechanism which moves the receiver up and down in a regular and predetermined manner. The telephone operator in the central station, knowing this signal to be caused by a fire, immediately sends for the fire department. This little device has thus performed its duty as satisfactorily as could a complicated, high-priced system.



Crib Arrangement for Bedsteads

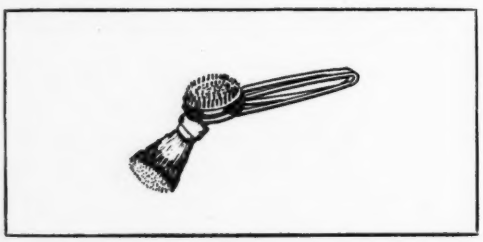
A crib which may be attached to the side of an ordinary bedstead, and which may be rocked by the mother without necessitating her getting out of bed, has recently been awarded a patent. Two wooden arms are bolted under the bedstead to hold the crib, which is suspended on these arms by four hinged supports. These supports permit of a lateral rock-



ing of the cradle, which is said to be as soothing to a fretting baby as the old-fashioned rocking cradle.

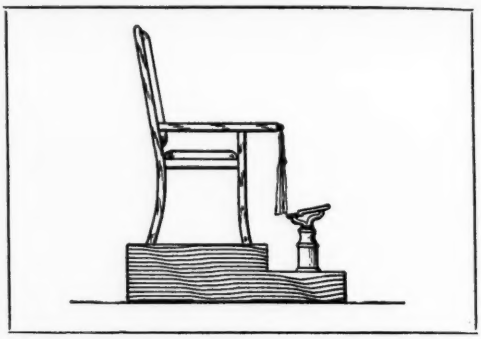
Lathering Implement

An instrument that obviates the laborious task of first lathering the face and then rubbing in the lather with the fingers to soften the beard has recently been granted a patent. A soft brush and a rubber bristled brush are both mounted on a light holder made of U-shaped steel wire. The face is first lathered with the soft brush, then the instrument is turned over, and the softening is done with the rubber bristles.



Curtain for Shoe-Polishing Chairs

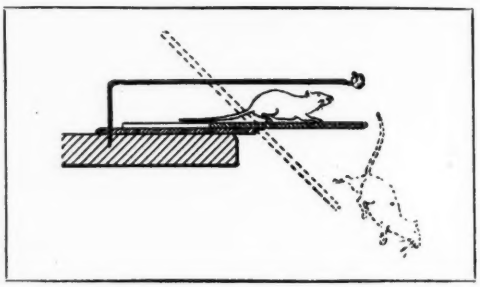
A victim of the wiles of a "shoe-shine artist" will no longer be forced to submit to having his trouser legs daubed to



the knees with polish and grease, for a Maryland inventor has recently patented a curtain which hangs from the extended arms of the chair and protects the sitter from the knees to the shoetops, as is shown in the accompanying illustration.

Novel Mouse Trap

An adaption of the familiar "see-saw" of our childhood days is the underlying idea for this novel mouse trap. A strip of wood is projecting well beyond the base of the trap, and is affixed to its support by a hinge. A piece of bait is held

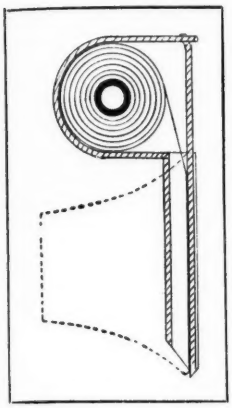


out on a wire over the projecting platform. When the mouse walks out on the platform to seize the bait the platform becomes overbalanced and tilts suddenly, dropping the mouse into a receptacle below.

An Austrian inventor has recently patented a design for umbrellas, shaping them like flowers. He believes this design to be superior to the familiar round pattern.

Sanitary Telephone Mouthpiece

Many inventions have been patented as improvements over the unsanitary telephone mouthpiece. One of the most recent patents for making this breeding place for microbes more sanitary is shown in the accompanying illustration. A roll of antiseptic paper is held in a dust-proof holder directly over the mouthpiece. The paper is drawn through a clip which holds it tightly over the transmitter. When a person goes to the instrument he pulls down the used section of the paper and tears it off, leaving a clean and hygienic surface to talk into.



Holder for Paint Brushes

A rack for holding paint brushes when not in use can be made from a length of stiff wire, bent into a series of loops and nailed down at either end.

Contributed by

B. W. VERNE.

To Preserve Useful Suggestions

The writer has gained many valuable suggestions from articles in this department on the subject of chemistry in which he is particularly interested. These articles are clipped each month and pasted in a note book for future reference. In the front of the book an index is written from month to month. This systematized "clipping bureau" has proved itself invaluable on more than one occasion.

Contributed by

S. D. WILLIAMS.

SAW-MILLS IN CITY STREETS

The conversion of fine residence streets into temporary wood-yards and saw-mills during the fall and winter months is a spectacle that never fails to amaze the stranger who chances to be in Portland, Oregon, at those seasons of the year.

Wood, which is the principal fuel used in both furnaces and fireplaces, is supplied and purchased in four-foot lengths and is cut to order for domestic use, sometimes by the dealer in his yard, but more often by an itinerant wood-sawyer equipped with a portable gasoline saw-mill mounted on an ancient automobile chassis.

ELECTRICAL RESISTANCE AS A CRITERION OF HEALTH

IMAGINE the physician in diagnosing your case, instead of taking your pulse and temperature, saying, "I think I had better take your electrical resistance." Removing from his bag a piece of apparatus somewhat similar to a medical battery, he proceeds to adjust a pair of electrodes and place a telephone receiver to his ear. After a moment or so he announces, "Your resistance is a few hundred ohms too low. Your cells need toning up."

In the future such an occurrence may be a reality instead of a flight of the imagination. In fact, with the perfection of apparatus and development of a proper technique, such a thing is entirely possible.

The cells, of which all living organisms are composed, possess semi-permeable membranes which have the power of excluding some substances while freely admitting others. If the vitality of the cells is decreased, this power of discrim-

inating between what shall be admitted and what shall be rejected is also diminished. When the cells are dead this power is entirely lacking and substances which would be excluded if the cells were alive readily pass through the plasma membrance surrounding the protoplasm of the cells.

By bringing living tissue in contact with a salt solution or some other electrolyte, arranging the electrodes so that the substance in solution must pass through the tissue, and then measuring the resistance that is offered to its passage, it is possible to tell whether the cells of the tissue are in a healthy condition or not. If the cells are in a healthy or vigorous condition they offer a high resistance to the passage of the ions, in other words, they are poor conductors; but if their vitality is low they offer less resistance, and, if dead, very little resistance. Very weak currents may be used, so that there is no injury to the living tissue from the effects of the electric current, this being fully determined by many experiments.

The cause of the high resistance of living cells is found in the semi-permeable membranes previously mentioned, and the resistance is proportional to the vitality of these membranes, and upon the vigor of the cells depends the health of the entire animal or plant, so that the resistance offered is a criterion of the health of the organism.

Prof. Osterhout of Harvard University has used this method in determining the effects of various substances, such as salts, alkaloids and anesthetics, upon plant cells, and has obtained more exact knowledge upon the subject of permeability than has hitherto been possible. Most of his experiments have been upon *Laminaria saccharina,* a species of kelp, but the same method with certain modifications can be used upon other plants and animals as well. The apparatus is so arranged that a weak alternating current must pass through the cells of the plant, and the resistance be measured on a Wheatstone bridge. Many substances that are injurious to the living cells are antagonized by other substances that are also harmful, so that a mixture of the two is comparatively harmless. This is frequently true even when no chemical combination of the two substances takes place. It is an odd fact that these marine plants soon die in a solution of common salt, although this is by far the largest mineral constituent of sea water. However, if a small quantity of a calcium salt be added, they live about as long as if they were in sea water. Either one of these substances alone is toxic, but a combination of the two in the proper proportions is harmless. They antagonize one another.

Dr. Osterhout's work has thrown much light on the manner in which anesthetics produce insensibility to pain. His experiments lead to the conclusion that the anesthetic raises the resistance of the nerve cells. It is probable that sensation is accompanied by electrical currents that pass along the nerves to the brain, and as the anesthetic raises the resistance of the nerve cells the current becomes too feeble, and a decrease or total absence of sensation results.

Biologists are now using this method upon animals and very recently on human beings. From recent experiments it is probable that very important discoveries will soon be announced. It is certain that the method will be extensively used in the future and altogether probable that it will be of service in the diagnosis of disease.—LEE MORRISON.

Electricity Direct from Coal

A patent has recently been granted a German inventor for an application of the familiar thermo-pile principle to the production of electric current in considerable quantities without the intervention of boiler, engine or dynamo. While the principle of the device is similar to that of the old-time thermo-piles, the present arrangement utilizes a furnace fitted with suitable couples made of heat-resisting materials, and it is said that the apparatus produces a current of such volume that it may be put to practical use. The cost of producing the current is said to be somewhat less than that of the usual method employing steam, and it is certain that the first cost of the plant is considerably less than that of a modern generating equipment.

The Home Craftsman

A Craftsman Desk Table

Describing the Construction and Finish of an Attractive Desk Table of the Arts and Crafts Style

By Ralph F. Windoes
Instructor of Manual Training, Davenport High School, Davenport, Ia.

PRODUCTS of handicraft unconsciously stamp themselves with the individuality of their maker. Snug-fitting joints; clean, sharp edges; a beautiful finish—and in the mind of the observer is seen the builder—neat, clean, and precise. Conversely, dirty work; open joints; smeared finish—and in one's mind flashes a picture of just such a workman. Hence, when we make the new claim for homecraft work—that it has a cultural value as well as an economic one—our contention among the observers will be substantiated.

Never leave a piece until it is just as good as you can make it. If you know that the distance between the shoulders of an end rail is 17", and of the corresponding stretcher for the same side is 16⅞", don't glue it up and close the gap with a tightly drawn clamp. You may be able to bend the leg, and by pinning the tenons, make them hold, but *you would be cheating yourself*. You would not be getting your full share of value from the work you were doing.

All handwork demands the utmost in exactness—an *inch* is an *inch*—not 31/32". Can you imagine a gas engine running whose cylinders were bored 1/32" larger than the pistons were turned?

I believe that there is a sermon in homecraft work. I once knew a slovenly workman who was keeping his own time on a job. He worked about eight hours a day—but his time went in for ten. "Oh that's near enough," was his motto. Now if that man in his work had never left a thing until it was *just right*, his morals would never have been so corrupted that he would steal from his employer.

Make the most of your opportunities. If you are building furniture for pleasure, see that you do each thing *just right*, and you will derive untold benefits from it.

With this issue we are presenting detailed drawings of a desk table. It is no project for the inexperienced to attempt, but an excellent one for the older homecraftsman. It demands the accuracy pleaded for above, and if given a reasonable amount of care, will resolve itself into an article of beauty and great usefulness.

Go to the mill with the following mill bill, and insist that each piece be cut to exact dimension and sandpapered. For stock, we would suggest nothing but quarter-sawed white oak, kiln dried, but the craftsman may prefer some other wood.

4 pcs.	1½" x 1½" x 28	"	legs
1 pc.	¾" x 23 " x 36	"	top
1 pc.	¾" x 6 " x 34	"	shelf back
1 pc.	¾" x 5 " x 31	"	back rail
2 pcs.	¾" x 5 " x 18	"	end rails
2 pcs.	¾" x 2½" x 18	"	stretchers
1 pc.	¾" x 8 " x 29¾"		lower shelf
1 pc.	¾" x 2½" x 31	"	lower back rail
2 pcs.	¾" x 2½" x 29¾"		for drawer support softwood
3 pcs.	¾" x 2½" x 13¾"		for drawer support softwood
1 pc.	¾" x 5¼" x 17¾"		partition
1 pc.	¾" x 1 " x 29	"	front of drawer support
2 pcs.	¾" x 5¼" x 14½"		drawer fronts
3 pcs.	½" x 3 " x 14½"		back slats
4 pcs.	½" x 3 " x 17	"	end slats
1 pc.	½" x 5½" x 32	"	top of pockets
4 pcs.	½" x 4 " x 5	"	ends of pockets
2 pcs.	½" x 5 " x 8	"	shelves
4 pcs.	½" x 5¼" x 16¾"		drawer sides softwood
2 pcs.	½" x 4½" x 13⅝"		drawer backs softwood
4 pcs.	½" x 16½" x 13⅝"		drawer bottoms softwood

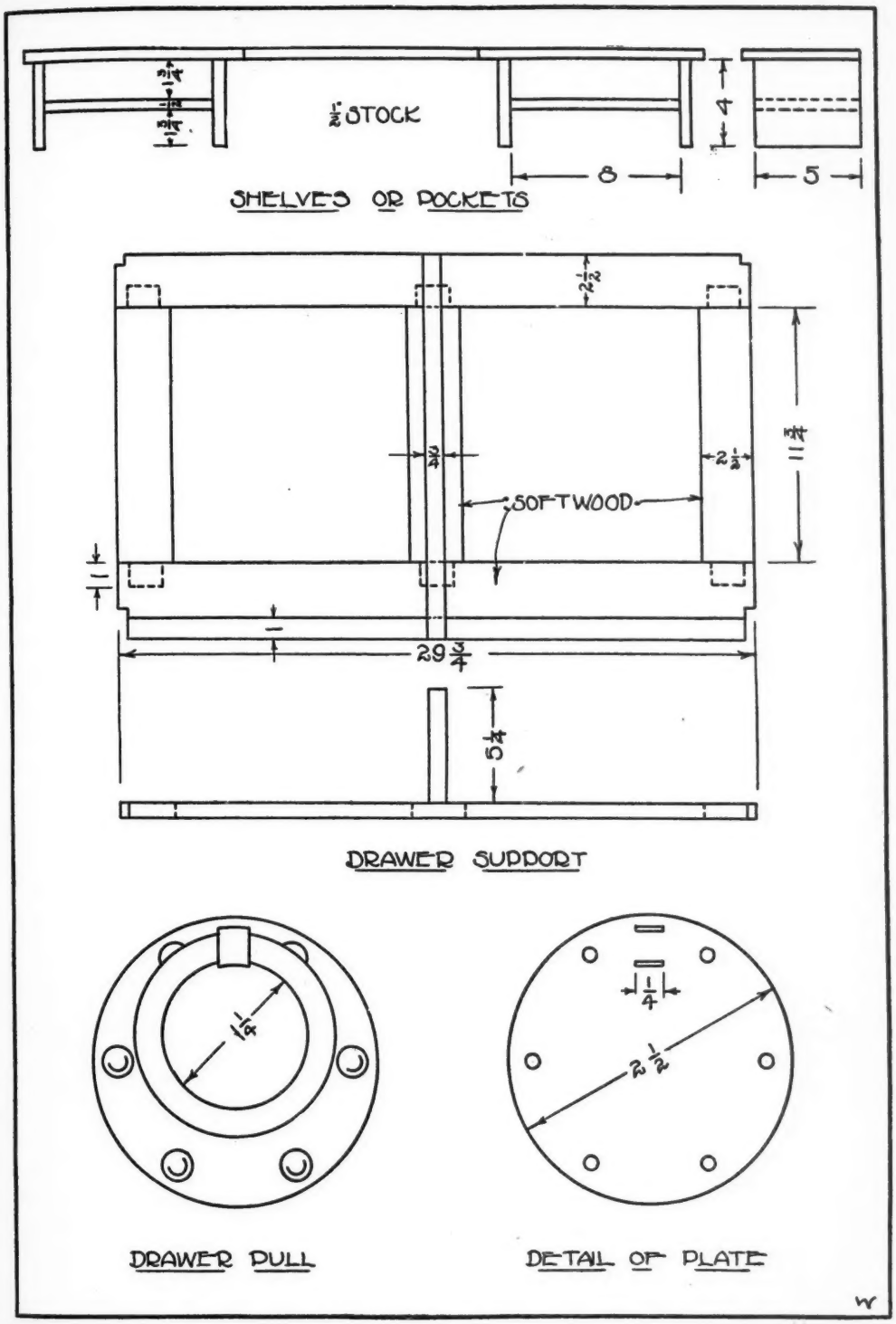
These mill sizes are exact. Any errors will necessitate the purchase of more lumber.

As is usual with these problems, begin the construction with the legs. Remember to carefully lay out the mortises in pencil before gauging and scribing. Cut the mortises—after first boring them out with a bit—perfectly square with the surface of the leg. Fit the corresponding tenons on the rails and stretchers and cut the little mortises in them for the slats. After fitting the slat tenons into these mortises, glue this much up. Next, construct the drawer supporting frame, as detailed, gluing the one inch strip of oak on the front edge. The drawer partition can be screwed onto the frame through the bottom of its middle member. To hold this frame in place, screw through it, diagonally from the inside, into the end rails and the back rail. In a similar manner, fasten the lower shelf in place. The top is held in place with right angle irons, or, better yet, with table top fasteners. The top shelves, or pockets, are constructed as detailed, and nailed together with brads the heads of which will be set and filled later. The shelf back is also detailed, and is held in place by screws put in from the under side of the desk top. The pockets are fastened to this back by screwing into them through the back. The two large drawers are built as usual, and should be just loose enough to slide easily into place.

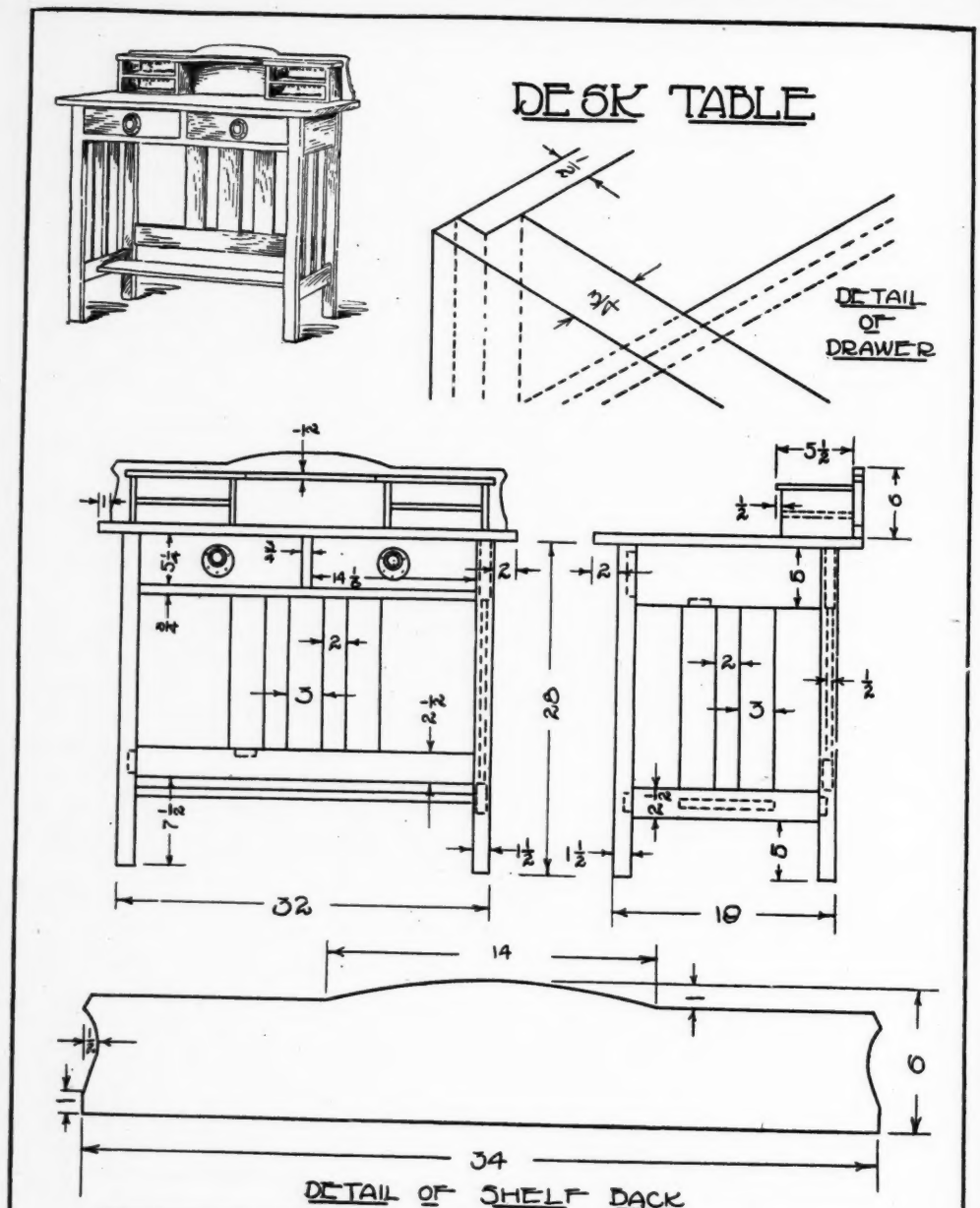
This will complete the construction, and the next step is the finishing. Be very sure that you clean up the wood thoroughly before starting this very important part of the building. By "cleaning up" is meant the scraping and sandpapering off of all glue, dirty spots, roughed up grain, and chatter marks. One word about sandpapering oak. Never use a *coarse* sandpaper, as you will probably tear up the soft part of the grain, thus forming large pores in the wood that are hard to fill in finishing. Number oo or number o is coarse enough, and be sure to wrap it over a smooth faced block of wood.

A somewhat different mode of finishing will be suggested. In the usual way, a coat of stain is applied, followed by a coat of filler. But these two can be combined in one, thus saving a little time in the finishing process.

Paste filler can be obtained from the manufacturer in cans of the natural, antique, golden, or weathered effects. These colors are all good, but, if the craftsman desires a different shade, he can thin out the natural paste filler with the desired color in an oil stain. The colored filler can be thinned with good turpentine or benzine, and it should be of the consistency of varnish when applied to the wood. Work it well into the grain with a rather stiff brush, and allow it to stand until it has lost its gloss. Then rub it, also across grain, with a pad made by gluing a piece of leather onto a block of wood. Wipe off all filler above the surface with tow, or a piece of old cloth. Remember, all rubbing and wiping must be done across grain. Give the filler at least thirty-six hours in which to dry, and then go over it lightly with number oo sandpaper. Examine the grain carefully—use a magnifying glass if necessary—to see that the pores are well filled and no pinholes visible. If any defects of this kind are noted, it is well to go over the surface with the filler a second time, but have it of thinner



Various details of the desk table, showing especially the upper portion of this piece of furniture, the drawer support and the drawer pull.



Additional details of the desk table, including a dimensioned drawing of the complete assembly as well as the appearance of the piece of furniture when finished.

consistency than at first, and repeat the operations of rubbing, wiping, and sandpapering.

Next apply one or two coats of white shellac, rubbing down each with fine sandpaper. If you desire a wax finish, apply a coat of good prepared wax, allow it to stand over night, and rub it to a high gloss in the morning. If a varnish finish is preferred, apply a coat of good hard oil varnish over the shellac coats, and, after two days, rub it down with Number 00 steel wool. Apply a second coat, and rub it down with pumice stone and water. This will give an agreeable dull gloss. If a polish is desired, rub the last coat with raw oil and rotten stone, and polish it with sweet oil. This finishing varnish should be one of the many brands upon the market that is not affected by water, as the top of the desk will collect more or less ink that must be washed off.

The drawer pulls may be purchased ready to attach, or the craftsman can construct his own. We have detailed the method on one of the drawings. Secure some Number 16 gauge soft copper or brass, and two solid rings whose inside diameter is about 1¼". From the sheet carefully cut two circles 2½" in diameter. File the edges smooth. At the top of each, cut two small holes ¼" long and as far apart as the rings are thick. Through these holes insert a strip of brass, with the rings in place, and spread their ends on the back like a paper fastener. Drill or punch six small holes around the edge of each plate through which drive large headed tacks to hold the pulls to the drawer fronts. The brass can be polished by rubbing it with steel wool, and applying a coat of banana oil to prevent it from tarnishing.

This desk table, if made carefully, should stand hard usage for years.

Stairway in Closet

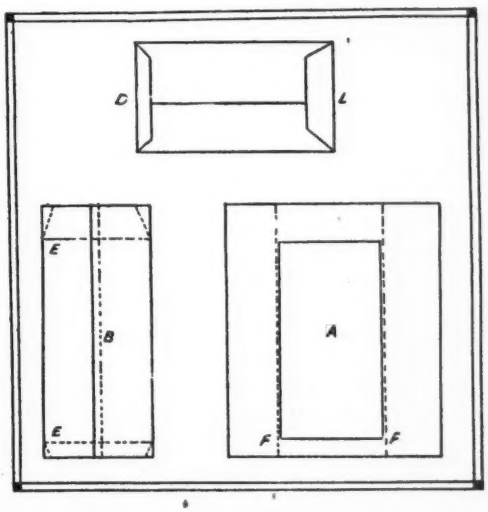
Many small houses are built with an attic, but with no means of getting to it except by way of a trap door. Where a stairway is desired and hallway room is scant, a set of stairs on a condensed scale can be erected in the clothes' closet of a bedroom. In the house of the writer there was a closet 33 inches wide, 10 feet high and 6 feet long, with a door at one end. The ceiling of the closet was sawed out and two boards, 1x6 feet, were placed at an angle so as to reach from the floor, just inside the door, to the top of the other end of the closet. Thirteen steps of the same material were fastened between these boards on cleats. Each step overlapped the other two inches. The stairway was made only 16 inches wide, so that the shelves at the back of the closet, and also the floor, could be used for storage purposes. To keep out the cold in winter, a screen door frame was covered with canvas and laid over the opening, as a trapdoor.

Contributed by

MARGARET W. MOODY.

Easy Way to Make Large Envelopes

Envelopes to suit any sized article can be easily made from a sheet of paper. Referring to the drawings, *A* represents



the object to be wrapped. To determine the width of the paper required for the envelope, the width of *A* should be dou-

bled and a half inch added. For length, the paper should extend about ¾ inch beyond one end of *A* and 1½ inches at the other. After the paper is cut to the correct dimensions, it should be folded along the dotted lines, *EE* and *FF*. The flaps, *D* and *L*, should be glued down.

Contributed by

C. H. PETERSON.

Home Made Fire Extinguisher

A fire extinguisher of some kind should be placed in every workshop. Chemical extinguishers are the most effective. One of this type which can be constructed easily and cheaply is described below.

In a syphon bottle a ½-inch layer of sodium carbonate crystals is placed. The bottle is filled ⅔ of the way with water containing one ounce of sulphuric acid. The metal cap is then screwed tightly in place. Carbon dioxide gas forms slowly as the crystals dissolve. By using crystals instead of powdered soda plenty of time is provided to screw the cap in place before the charge forms.

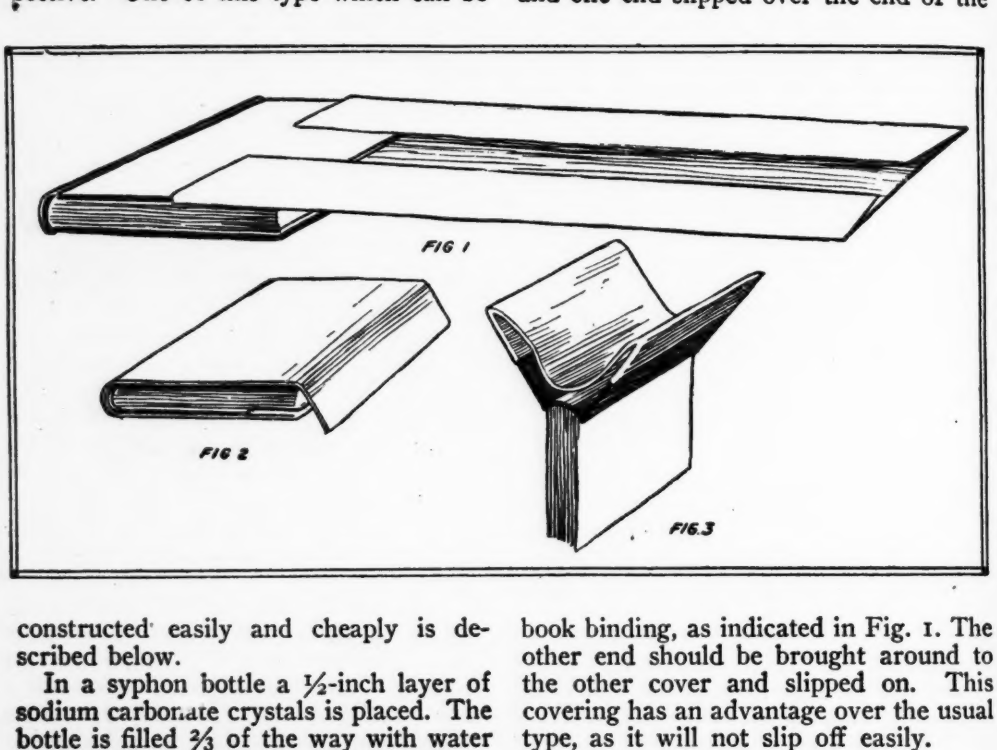
Sufficient gas is generated in the syphon to expel the liquid contents at considerable pressure. There is no danger of the bottle exploding as the walls are thick enough to withstand a high pressure. The effective range of the syphon-extinguisher can be greatly increased by soldering the tip of an oil can to the nozzle.

Contributed by

J. F. BIRCHLER.

A Book Cover

A protective covering for the binding of books can be made from strong drawing paper. It should be cut about one and two-thirds times the height and length of the book. The two edges of the long side should be folded inward, and one end slipped over the end of the book binding, as indicated in Fig. 1. The other end should be brought around to the other cover and slipped on. This covering has an advantage over the usual type, as it will not slip off easily.



Contributed by

C. H. PETERSON.

A Lamp Bulb Magnifying Glass

A magnifying glass of strong power can be made by filling a burned out lamp bulb with water. The bulb should be submerged in a basin of clear water and the tip broken off with pliers. The

vacuum will cause the water to rush in through the small opening until the bulb is filled. Distilled water is preferable.

Contributed by

S. TONNER.

Clothes Pin for Lamp Cord Adjuster

In the cellar and attic, where elegance is not essential in electric lighting service, a clothes pin can be used in place of the expensive lamp cord adjuster. The cord is looped and forced into the slot between the lines.

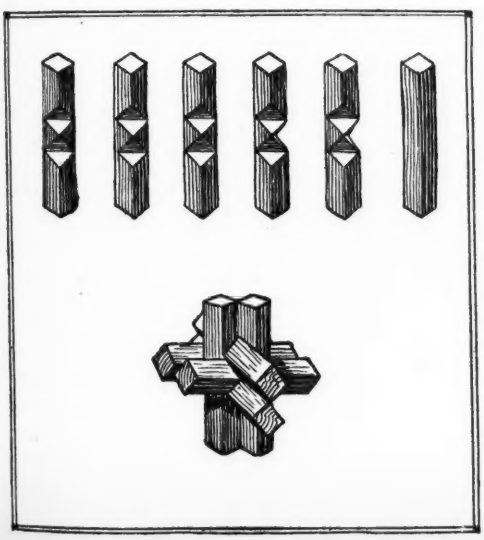
Contributed by

WALTER FRANSEEN.

To Whittle "Carpenter's Knot"

The "carpenter's knot" is a complicated structure of small blocks of wood, correctly whittled and glued together. Six sticks of wood are necessary. Notches should be cut along their edges as shown in the accompanying drawings. To assemble, place numbers 2 and 3 vertically on either side of No. 1 at its center. Place numbers 4 and 5 on either side of numbers 2 and 3, resting the notches in No. 1. This leaves their third notches open, forming an opening with the space left in numbers 2 and 3 into which No. 6 is snugly pushed. Unless one is acquainted with the structure, dissembling the carpenter's knot is a difficult task.

Contributed by L. K. HALLOCK.



Ingenious Container for Harness Thread

A rat-proof holder for harness thread can be made from a small tin can with a hole cut in the top, through which the thread passes. The end of a clock spring, one edge of which has been sharpened, may be soldered to the top to serve as a knife.

Contributed by

J. G. LUNDHOLM.

Inexpensive Lawn Sprinkler

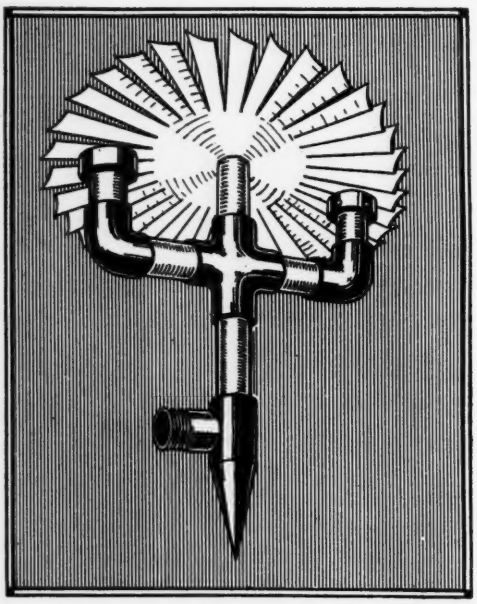
The parts necessary in the construction of the lawn sprinkler shown in the accompanying drawings are as follows:

2 ⅜" elbows.
2 ⅜" x 1½" nipples.
3 ⅜" x 2½" nipples.
1 ⅜" cross tee.
1 ⅜" tee.
2 ⅛" x 1" brass washers.
2 ⅜" pipe caps. These should be drilled with two 3/32" holes, 5/16" apart, center to center.

1 ⅜" pipe, 12" in length. This should be tapered to a point at one end. It serves as the standard, and is to be driven into the ground.

1 ⅜" x 5½" round brass rod.

1 ⅛" x 8" brass disc. The edge should be divided into 21 equal parts. With a hack saw, 21 3" slots should be cut toward the center. The blades thus formed should be bent upward, thus forming a fan-like wheel. The brass washers should be soldered to this wheel, one on each side, to act as bearings.



The various parts should be assembled as shown in the drawing. When the water is turned on, the wheel will revolve and scatter water to a considerable distance.

Contributed by

HENRY G. SMITH.

Mending Broken Glass Article

Articles of glass, such as tumblers, fruit dishes, lamp chimneys, globes and other similar bric-a-brac, can be mended when broken with the following preparation: Take five parts of gelatin to one part of a solution of acid chromate of life. Cover the broken edges with this and press together, then place in direct sunlight for a few hours. The mended article will not come apart even if washed in boiling water, nor will the breaks show. Try it!

Contributed by

CLARENCE T. HUBBARD.

Handy Attachment for Auto Horns

Most makes of cars have the push button controlling the horn placed on the inside of the frame at the side of the driver's seat. This puts it in a most inconvenient position. To improve matters, connect one side of the button to any bolt on the auto; the other terminal being led up into the driver's glove and screwed firmly to same. A break is made at the cuff of the glove and a small slip socket inserted in the line. At the tip of the little finger, where the wire ends, solder a small ring of metal; when this ring is brought into contact with the nearest part of metal on the steering wheel the horn will sound.

Contributed by

AUGUSTUS SAULTIS.

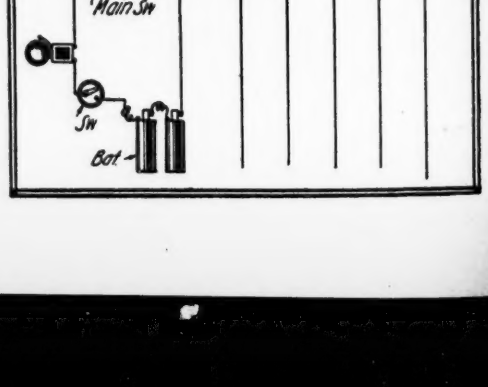
Fire Alarm for Hay Lofts

An alarm system which will give prompt warning when a fire starts in a hay loft may repay by a saving of hundreds of dollars the few minutes of time that are required for its construction.

A one-point battery switch is mounted on one of the beams near the roof. Wires lead from it to batteries and a bell which should be located some place in the house where it can be heard readily. A light string should be stretched from the handle of the switch to the opposite side of the loft. A rubber band or light helical spring, pulling in the opposite direction to the cord, should be stretched to a hook behind the switch. When the string is taut, the circuit remains open and the bell does not ring. A fire will quickly burn the string, releasing the switch handle, which is drawn back to the contact point, and the bell rings the warning immediately.

Contributed by

WILLIAM WARNECKE.



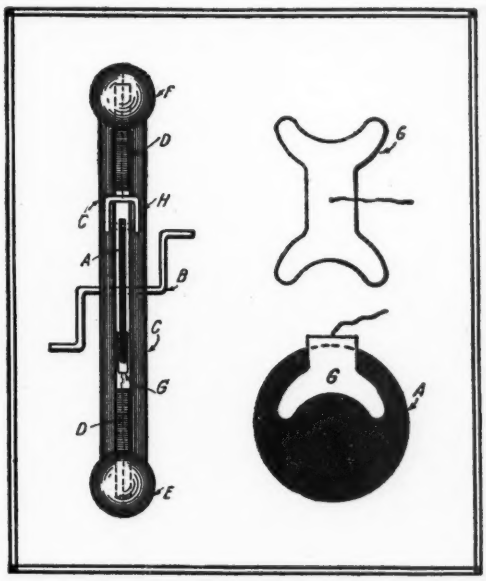
For Practical Workers

An Exciter for Electrostatic Experiments

By H. John Gray

WORKERS in the fascinating field of electrostatics, often termed "frictional electricity," will find the appliance described below very useful for many purposes. It gives a continuous stream of tiny sparks, either positive or negative as desired, and is especially useful for exciting larger machines, charging proof panes, etc., without the bother associated with the use of an electrophorous.

Exact dimensions will not be given, but an overall length of 9 or 10 inches will be sufficient. The electricity is generated by the rotation of a disc of ebonite between two fur rubbers, the former becoming negatively electrified and the latter positively. Fig. 1 shows the parts. The ebonite disc, *A*, which may be about 3½ inches in diameter and thick enough to be rigid, is mounted on an axle, *B*, the ends of which form handles. The necessary support is given by two strips of ebonite, *cc*, about ¼ inch square in section, holes being made in the center of each and bushed with short lengths of brass tube, no longer than the thickness of the rods. The ends are strengthened with shorter pieces of ebonite, *DD*, drilled lengthwise to accommodate wires and projecting a little beyond the longer strips. To these projecting ends two large brass balls, *E* and *F*, are securely fixed. Bedstead knobs or certain kinds of door handles answer the purpose very well, but the surface must be plain, not fluted or ornamented in any way, and should be made quite smooth and bright. The rubber and collecting points are shown at *G* and *H*.



Details of a simple static generator that may be used in experimenting with this form of electricity.

The details of the disc and rubber are shown in Fig. 2, where *A* is the circle of ebonite perforated at the center, *B*, to take the axle, the rubber being shown in position at *C*. This is made from a piece of thin sheet copper, cut to the shape shown at *D*, and having a few inches of copper wire soldered to the

middle of the narrow part. It is important to file the edge quite smooth, as well as the solder with which the wire is affixed. If any sharp points are left they will cause a loss of electricity.

Two small pieces of fur, such as moleskin, should be attached with glue to the crescent-shaped portions of the copper, on the side opposite the soldered wire. When dry the rubber may be bent to press lightly against both sides of the ebonite disc when in position.

A small collecting comb, Fig. 3, will be required to collect the charge from the surface of the ebonite disc. This can be made from stout brass wire bent as shown and having two pin points soldered to each end. These must be of exactly equal length. A few inches of copper wire must be soldered to the frame for connecting with one of the brass balls.

The separate parts having been prepared, they may be assembled in the following order: A length of straight, stiff brass wire should be used as a handle and passed through both the ebonite strips with the disc in between. The latter should be held firmly and must rotate quite true, so as not to touch the supporting strips on either side. A pair of tiny metal or wooden washers will give sufficient strength.

The ends may then be bent carefully to form handles. Inside each brass ball solder a short piece of copper wire, with the ends outside. Thread the wire from the rubber through one of the ebonite end pieces (*D*, Fig. 1), and twist the end tightly to the wire projecting from one of the balls. Connect the collecting comb with the other ball in a similar manner.

It only remains to fix the ends securely with the brass balls in position. To do this first secure one of the end pieces in each ball by partly filling the latter with pitch. The ends should be bound firmly with stout sewing silk.

The rubbers and collecting comb will be approximately in position, but should be adjusted and firmly secured. The rubber should grip the disc firmly and be fastened with two small pads of leather or strips of india rubber, one on each side. Both sides of these should be coated with bicycle-tire cement, to grip both the copper segment and the inside of the ebonite frame.

To adjust the collecting comb, the pin points should be set rather close to the disc, but not touching it, as the latter rotates between them. It may be held in this position by means of two strips of strong adhesive tape.

The instrument is very simple to use. If positive sparks are required grip the negative ball in the left hand and turn the handle, presenting the positive ball to the apparatus to be charged. If a negative charge is wanted, simply reverse the ends. It will be found convenient to mark the balls so that their polarity can be seen at a glance—the rubber end being positive and the comb end negative. As electricity of both signs is produced one of the charges must be conducted away through the body of the operator. The machine is only intended to give quite small sparks, but it is much too powerful for charging a gold leaf electroscope.

Difficult Small Castings

Occasionally the experimenter has need of small castings of intricate shape which would hardly warrant the making of core prints. The pattern is first made in wax procured from any dentist or dental supply house and carved into proper shape with the aid of a slightly warmed knife. It is next smoothed down to a glossy finish with gasoline or commercial chloroform applied with a pledget of cotton. Then a mixture of one part sharp sand and three parts plaster of paris is made and the pattern covered with it. This investment should have just enough water in it to make a thick, creamy mass. Cut a pouring vent through the plaster so as to expose the wax. Place the investment in boiling water until all wax is out of the mold and heat in oven till very dry, then pour the metal through vent. It is an advan-

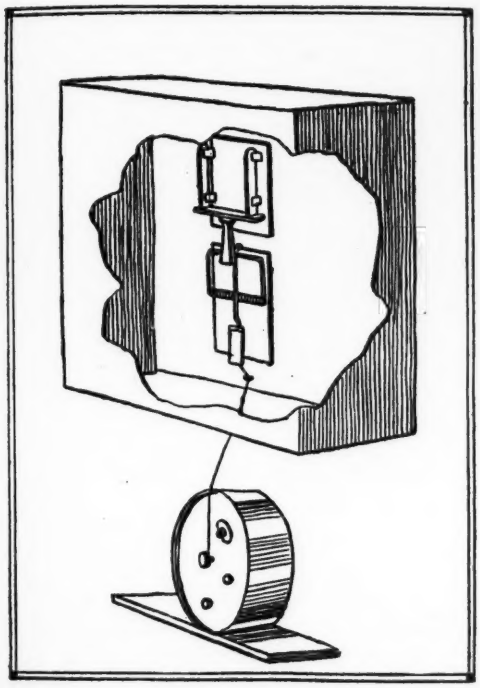
tage to make one or two air vents to allow the steam and gases to escape when pouring.

Contributed by

AUGUSTUS SAULTIS.

Time Clock Switches Off Lights at Desired Time

A time switch can be constructed that will turn out the electric lights in a show window at any desired time. A knife



switch, an alarm clock and a rat trap of the "spring-tension" type are the necessary parts of the apparatus.

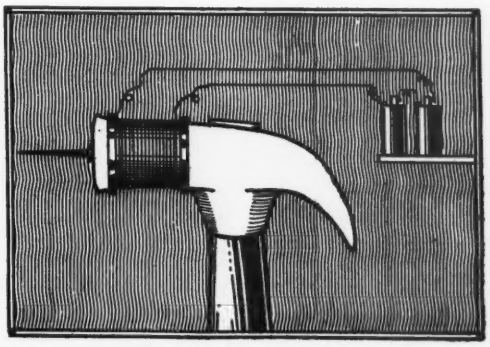
The knife switch is connected in the circuit through which the current for the lamps flows. Beneath the switch handle, the rat trap should be fastened by screws or nails to the wall. When the trap trigger is pulled, the spring will fly up, disengaging the blades of the switch. A strike or wire should be connected to the trap trigger and tied to the alarm winding key of the clock. When the prescribed time arrives, the key will tighten the cord, pull the trigger, release the spring, and the switch handle will be thrown up.

Contributed by

E. A. HODGSON.

Magnetic Hammer Holds Nails

A magnetic hammer that will hold nails while they are being started in a



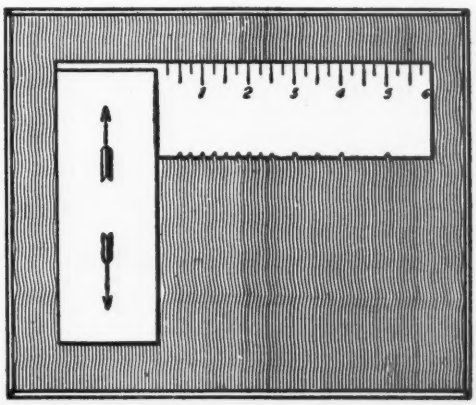
board can be made by winding several layers of magnet wire around the hammer head. Three or four dry cells will provide sufficient current. A spring switch of some kind may be attached to the handle, so that the batteries will not be worn out when not needed.

Contributed by

WILLIAM WARNECKE.

Using a Try Square as a Marking Gauge

A try square can be used as a marking gauge if the lower edge of the indexed



blade is cut with notches to correspond to the numerals. A marking groove can be cut in a board by placing the point of a nail in one of the notches.

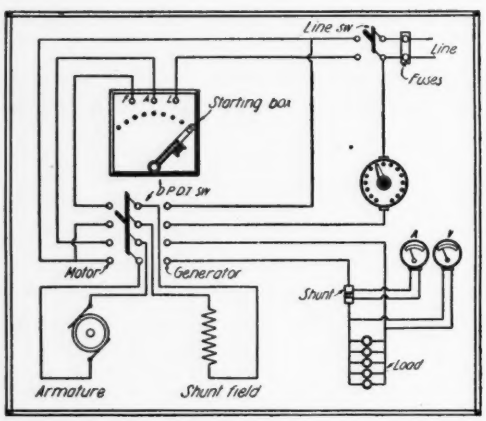
Contributed by

F. M. DEFANDORF.

Wiring Diagram for Converting Motor to Dynamo, or Vice Versa

A wiring diagram is shown herewith by means of which a power motor may be converted into a dynamo, or a dynamo into a motor.

To use either as a motor or as a generator, the line switch must first be thrown in. To use as a motor the four-



pole double-throw switch is thrown to the motor side, and the motor is started with the motor rheostat handle.

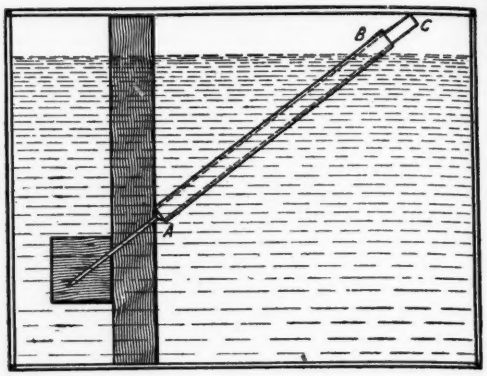
To use as a generator the four-pole double-throw switch is thrown to the generator side. The voltage may be regulated by the generator field rheostat. The load may be varied by separate switches, not shown in the diagram.

Contributed by

EDWIN J. ISRAEL.

Driving Nails Under Water

An ingenious method of driving nails under water is shown in the accompanying drawing. A nail is placed, point outward, in the end of a length of gas pipe over the spot where the nail is to be



driven. A stiff rod is inserted in the hole of the pipe and struck with a hammer until the nail is driven entirely in.

Contributed by

HERBERT BAMBRICK.

To Repair Broken Celluloid

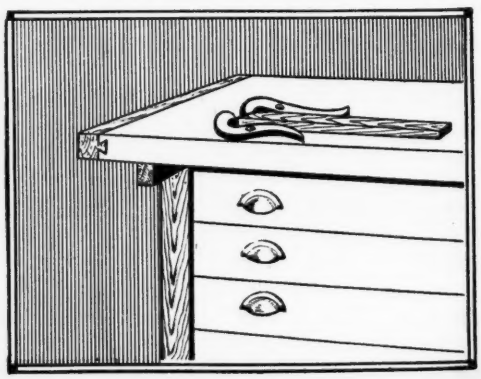
Broken celluloid articles can be repaired with a cement properly formulated. The broken fragments should be cleaned thoroughly with soap and water, and when dry, painted at the fractured edges with Acetone of Merck. The Acetone will blow between the cracks, softening the adjacent celluloid. After a few minutes, the liquid will evaporate, and the joint harden.

Contributed by

FRANK R. BENNETT.

Clamps Boards Without Marring

If two "S"-shaped wooden cleats are screwed pivotally to the top of a work



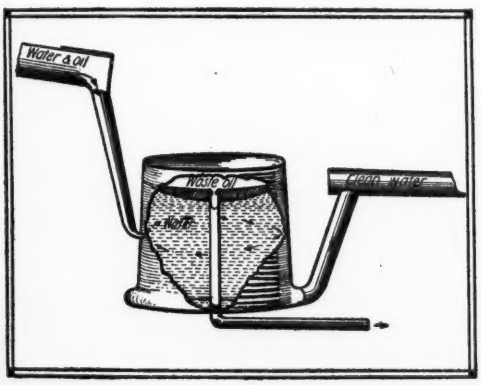
bench, mahogany, oak and boards of similarly expensive woods can be held firmly without their surfaces becoming marred. The cleats may be set at any desired distance apart, to accommodate boards of any thickness.

Contributed by E. B. W.

Oil and Water Separator

In many places, especially in the oil fields of this country, petroleum collects about the wells and finds its way into small streams. The amount of the oil is often not worth saving, but it is carried away where it does damage often to the extent of lawsuits. The usual preventive method is to build dams, draw the water off at the bottom, and the oil at the top. This method is expensive and not satisfactory.

The accompanying illustration shows a separator that may be constructed cheaply. Oil and water enter the side of the tank, or separator, under a head of several feet, so that it is injected into the tank with some velocity and in such a



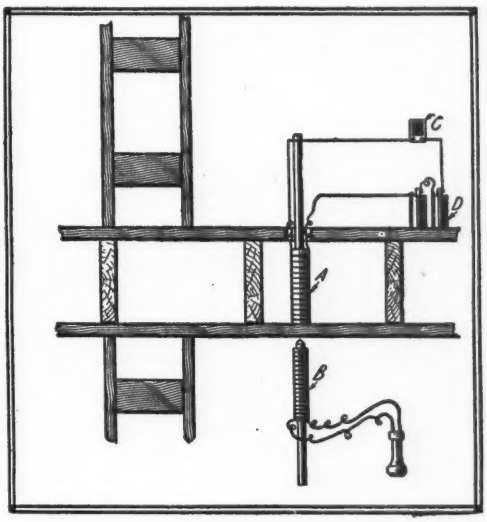
direction that the fluid in the tank will whirl. This whirling motion throws the water to the outer part, while the oil collects on the top of the water and in the center. The water is drawn off at the outer edge and bottom of the tank and pumped up to a "laundry," the bottom of which is an inch to three inches below the oil outlet. The outlets should be of sufficient size to cause no backing of either fluid in the separating tank.

Contributed by

ROBERT W. PHELPS.

Boring Holes with Aid of Inductance

It is frequently necessary to bore holes through floors and partitions when an extension bit is not available. In such



an exigency the following suggestion will be of value.

Cut two lengths of soft iron rod, ¼ inch in thickness and 2 feet in length. Wind one of them, *A*, with two layers of No. 18 D.C.C. magnet wire. File one end of the other rod, *B*, to a point and wind it likewise with two layers of wire. No. 28 or No. 30 D.C.C. magnet wire should be used.

The drilled hole in the floor or partition should be as deep as possible, and the rod, *A*, inserted, previously being connected in series with a buzzer and dry cells.

Rod *B* should be connected in series with a telephone receiver and moved about on the opposite side of the partition until the buzzer can be heard loudest. At this spot, dent the wall with the point of the rod and bore a hole. If care is taken the two holes will be exactly opposite.

Contributed by A. SUHER.

Hints for Workers in Iron

By means of carbolic acid a hole ¼ inch in diameter has been bored through ½-inch thickness of cast iron, with a common carpenter's brace; judge, then, what can be done by using the acid and a pressure drill.

To scale cast iron mix one part of sulphuric acid with two parts of water; brush the solution on the iron with a cloth until the surface is wet well. After nine or ten hours wash the surface with water and the scaly surface will have disappeared.

To make cast iron take a polish like steel, treat it in the following manner: Dissolve in one quart of hot water one ounce of copper sulphate, one ounce of prussiate of potash, one ounce of charcoal, eight ounces of salt and then add one gallon of linseed oil. Mix well and after bringing the iron to the proper heat cool it in this solution.

To tin cast iron cleanse it well and then rub it with a coarse cloth dipped in muriatic acid. Then, with the same cloth, rub it with French putty, which may be made by dissolving in mercury all the tin filings it will hold.

Contributed by

M. F. FLAVIAN.

Casting Aluminum

Nearly every experimenter requires, at one time or another, castings of irregular objects, and as very few people have the apparatus necessary to produce the heat required to fuse the harder metals, such as iron, brass and copper, most amateurs resort to lead. In many cases, lead is quite satisfactory, as, for instance, in objects requiring no great strength, and not subject to heat or requiring considerable weight, such as keels for boats, weights and plugs. In a great many cases, however, a harder metal is very necessary, as in stove doors, irregular supports, bases, containers for certain instruments, and thousands of other objects. In such cases aluminum can generally be used with satisfaction.

There seems to be a general idea that aluminum requires a high temperature for melting. In reality the melting point of aluminum is comparatively low, about 650° F., for pure aluminum, as a matter of fact, is readily melted by the heat from an ordinary coal fire. It is, of course, necessary to make the fire burn briskly by giving it plenty of draft. The aluminum can be melted in an iron or brass ladel.

As aluminum dissipates heat very rapidly, it must be handled rather quickly, but if melted in a heavy ladel the metal will remain in a liquid state for some time. Because of the excessive shrinkage of aluminum, it is necessary when casting to allow for this loss either by the use of an oversized pattern or, in case an open mold is used, by adding aluminum as the casting cools.

Aluminum is strong and tough, and is maleable when cold. In repairing broken parts of any metal with aluminum, although great difficulty may be encountered in an attempt to weld them, a great deal can be accomplished by cutting expanding cavities, filling them with aluminum, and thus anchoring the pieces together.

Contributed by

R. U. CLARK, 3D.

Helical Wire Springs

Calculating helical springs is not such a difficult problem as a great many machinists and draughtsmen imagine. A method is shown herewith, which has been employed in figuring springs, always with correct results.

The formulae for helical springs is taken from Kent's "Mechanical Engineer's Pocket Book," and the values in the table are the results obtained from these formulae.

The correct method of drawing springs is also shown and an example is given of figuring a spring for carrying 100 lbs., as a maximum load and to perform its work in 2". This spring is 9" closed and 11" semi-opened. Using this example as an illustration, square or round springs can be figured with little difficulty.

Those who have had experience well know that a helical spring as wound on

Formulas for Helical Spring Wire (Kent)

D = outside diam of spring
W safe load carried in lbs.
F deflection of 1 coil per one lb.
d diam. of wire
S fibrestress
E torsional modulus of elasticity
W. for sq. stl. = 1.2×ld. in table
F. for brass = fig. in table × 2

S-use 60,000
S use 50,000 for contin'ous work.
S 10,000-20,000 lbs. for brass.
E 12,000,000 in calculating table.
F. for sq. stl = fig in table × .59

Section from spring Table figured from 'Kents' formulas

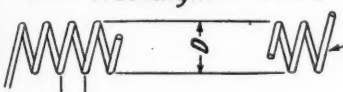
# 7 .177	D	1.00	1.25	1.50
	W	157	122	99
	F	.00038	.00083	.0015
# 3 .244	D	1.50	1.75	2.00
	W	250	2 25	195
	F	.00037	.00051	.0008

For square steel $W = 471\frac{Sd^3}{(D-d)}$ $F = 4.712\frac{P(D-d)^3}{E\,d^4}$

For round steel $W = 3927\frac{Sd^3}{D-d} = \frac{.3927\times 60{,}000\times 177^3}{1.073} = 122$ lbs. $F = 8\frac{P(D-d)^3}{E\,d^4} = \frac{8\times 1.073^3}{12{,}000{,}000\times 177^4} = .00083$" def.

Method of Drawing Springs

Method of squaring ends



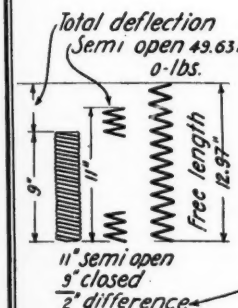
Before squaring ends

Pitch = Length / Nº working coils

Compression spring

Spring maker requires
- Nº working coils & pitch
- Size of rod over which spring is to work
- Free length
- Outside diam.
- Size and kind of wire

Example



Maximun load 100 lbs. and to work from 9" to 11" - 1¼" O.D.
Nº 7 = .177 wire

coils defl. lbs
47.84 × .00083 × 100 = 3.97" total defl.

$\frac{9"}{.177}$ = 50.84 coils
3.00 coils for squaring ends
47.84 working coils

3.97" total deflection
9.00"
12.97" free length
11.00
1.97"

Proof = $\frac{100\#}{50.37\times 47.84\times .00083} = \frac{49.63\#}{2"}$ $\frac{1.97"}{.00083\times 47.84} = 49.63$ lbs.

Problems

Problem #1:- Draw compression spring O.D. 1½" and 10¾" free length, #3 (= .244") wire 29.8 working coils 8" closed and 9" semi open, pitch 11/32". This spring to perform its work in one inch.

Problem #2:- Draw tension spring O.D. 1½" and 7¼" free length, #3 (= .244") wire 30 working coils.

Problem #3:- Draw compression spring O.D. 1½" and 8⅜" free length 25 working coils ¼" square spring steel, wire, pitch 11/32". This spring to perform its work in ¾ inch.

Problem #4:- Figure spring in problems similar to example using 250 lbs. for max. load.

HELICAL WIRE SPRINGS (ROUND WIRE)

#													
28	D	.20	.25	.3125	.375	.4375	.500	.5625	.625	.75	.875	1.00	
.016"	W	.524	.41	.31	.27	.23	.20	.175	.16	.13	.11	.098	
	F	.0632	.1302	.302	.470	.760	1.150	1.66	2.30	4.02	6.95	9.42	
24	D	.25	.3125	.375	.4375	.500	.5625	.625	.75	.875	1.00	1.125	
.0225"	W	1.18	.92	.76	.45	.56	.50	.45	.37	.31	.28	.24	
	F	.0278	.0631	.1135	.1875	.282	.408	.569	.975	1.660	2.42	3.46	
22	D	.25	.3125	.375	.4375	.500	.5625	.625	.75	.875	1.00	1.125	
.028"	W	2.35	1.84	1.49	1.26	1.095	.96	.865	.715	.61	.53	.47	
	F	.0119	.0250	.0453	.0742	.1140	.165	.231	.408	.660	.995	1.42	
20	D	.25	.3125	.375	.4375	.50	.5625	.625	.75	.875	1.00	1.125	
.035"	W	4.7	3.64	2.97	2.5	2.18	1.92	1.72	1.42	1.20	1.05	.93	
	F	.00451	.00952	.0175	.0292	.0447	.0651	.0914	.163	.264	.400	.575	
19	D	.25	.3125	.375	.4375	.50	.5625	.625	.75	.875	1.00	1.125	
.041"	W	7.87	6.05	4.93	4.15	3.58	3/16	2.82	2.32	1.97	1.74	1.54	
	F	.00234	.0047	.0088	.0106	.0228	0 334	.0410	.842	.1370	.208	.305	
18	D	.25	.3125	.375	.4375	.50	.625	.75	.875	1.00	1.125	1.25	
.047"	W	12.05	9.2	7.4	6.57	5.4	4.23	3.48	2.95	2.85	2.27	2.02	
	F	.00115	.00294	.00488	.00824	.0132	.0187	.0396	.0785	.126	.175	.242	
17	D	.25	.3125	.375	.50	.625	.75	.875	1.00	1.125	1.25	1.50	
.054"	W	18.9	14.3	11.5	8.3	.647	5.32	4.5	3.91	3.45	3.1	2.56	
	F	.00059	.00138	.00256	.00702	.0145	.0267	.0437	.067	.0971	.1502	.228	
16	D	.25	.375	.50	.625	.75	.875	1.00	1.125	1.25	1.50	1.75	
.063"	W	31.5	18.8	13.8	10.5	8.57	7.25	6.28	5.04	4.96	4.1	3.50	
	F	.00026	.00122	.0031	.00704	.0129	.0233	.0327	.0476	.066	.118	.190	
15	D	.375	.500	.625	.75	.875	1.00	1.125	1.25	1.50	1.75	2.00	
.072"	W	29	20.5	15.85	12.92	10.9	9.46	8.35	7.45	6.75	5.25	4.53	
	F	.00066	.0018	.00404	.0074	.0124	.0189	.0279	.039	.0697	.116	.204	
14	D	.375	.50	.625	.75	.875	1.00	1.125	1.25	1.50	1.75	2.00	
.08"	W	41	28.2	22.2	18.1	15.2	13.15	11.6	10.35	8.52	7.25	6.3	
	F	.00041	.00128	.0034	.0057	.0082	.0127	.0186	.026	.0548	.0757	.116	
13	D	.500	.625	.75	.875	1.00	1.25	1.50	1.75	2.00	2.25	2.50	
.092"	W	45.7	35	28.4	23.8	20.3	16.15	13.15	11.25	9.72	8.65	7.75	
	F	.00063	.0014	.00266	.0045	.0072	.0148	.0266	.0425	.0658	.081	.131	
12	D	.625	.75	.875	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	
.105"	W	52.5	42.2	35.4	30.4	23.8	19.5	16.6	14.4	12.7	11.4	10.3	
	F	.00069	.00148	.0026	.0039	.0083	.0149	.0245	.0374	.0545	.0734	.102	
11	D	.75	.875	1.00	1.25	1.50	1.75	2.00	2.25	2.500	2.75	3.00	
.120"	W	65	54	46	36	29	25	22	19	17	15.5	14	
	F	.0008	.0013	.00219	.0046	.0084	.0139	.0213	.0311	.0433	0.568	.077	
10	D	.875	1.00	1.25	1.50	1.75	2.00	2.25	2.500	2.75	3.00	3.25	
.135"	W	77	67	52	42	36	31	27	24	22	20	18	
	F	.00081	.00135	.0027	.0051	.0084	.0129	.0191	.0266	.0358	.0475	.0608	
9	D	1.00	1.25	1.375	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50
.148"	W	90	69	62.4	56	47	41	38	32	29	27	24	23
	F	.00065	.0019	.00257	.00317	.0056	.0078	.0131	.018	.024	.0313	.0413	.0522
8	D	1.00	1.25	1.375	1.500	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50
.162"	W	120	98	82.5	76	64	55	49	43	39	36	33	30
	F	.00057	.0012	.00173	.002	.0055	.0059	.0088	.0126	.0168	.022	.0285	.0364
7	D	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	
.177"	W	159	122	99	83	72	62	56	51	46	42	39	
	F	.00038	.00083	.0015	.0026	.0041	.006	.0083	.0115	.0154	.0196	.0249	
6	D	1.25	1.375	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00
.192"	W	158	141	128	107	92	81	72	65	59	55	50	44
	F	.00057	.000812	.0011	.0018	.0028	.0042	.0059	.008	.0107	.0138	.0174	.0266
5	D	1.375	1.500	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00	4.50
.205"	W	173.5	155	131	113	99	88	80	70	67	61	53	47
	F	.000604	.0008	.0014	.0022	.0032	.0041	.00617	.0082	.0106	.0134	.0222	.0298
4	D	1.375	1.600	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00	4.50
.225"	W	233	210	175	150	132	118	106	97	89	82	71	63
	F	.000408	.00053	.0009	.0015	.0022	.003	.0041	.0065	.0071	.0091	.013	.0202
3	D	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00	450	
.244"	W	250	225	195	170	152	136	125	114	105	88	80	
	F	.00037	.00051	.0008	.0012	.00198	.0029	.0039	.0051	.0065	.0086	.0116	
2	D	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00	4.50	5.00
.263"	W	345	290	250	215	192	175	156	146	134	115	100	90.5
	F	.00026	.00046	.00073	.0011	.0015	.0021	.0027	.0037	.0047	.0072	.0106	.0148
1	D	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00	4.50	5.00	
.283"	W	360	310	270	240	215	195	180	165	145	127	113	
	F	.00031	.00055	.00078	.0011	.0015	.0021	.0027	.0034	.0053	.0077	.0128	
0	D	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00	4.50	5.00	
.307"	W	470	400	350	310	280	250	230	212	185	162	145	
	F	.00031	.00038	.00055	.00079	.0011	.0015	.002	.0024	.0033	.0055	.0077	
00	D	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00	4.50	5.00	5.50	
.331"	W	510	445	390	350	320	290	270	230	205	183	165	
	F	.00029	.00039	.00056	.00078	.0010	.0014	.0017	.0027	.0041	.0056	.0075	
000	D	2.00	2.25	2.50	2.75	3.00	3.25	3.50	4.00	4.50	5.00	5.50	
.362"	W	700	610	540	480	435	400	365	315	280	250	225	
	F	.00017	.00026	.00038	.00053	.00071	.00094	.0012	.00186	.00276	.0033	.0052	

an arbor in a lathe may be of a given length, but that after it is taken from the arbor and compressed, coil to coil, it will not come back the same length as previously wound, on account of the "set," which takes place in the spring.

For example, a spring which is made of ½" round spring steel 3" in diameter on the outside, having nine coils and measuring 6 11/16", when compressed coil to coil would, after compression, measure only 6⅜". Therefore, that spring had a 5/16" set, or was shortened by that amount, and in constant use the spring would always open 6⅜" in free length.

The spring above referred to was wound cold. After a spring is wound and the end squared, it should be baked in an oven heated to a temperature of 400° to 500° Fahrenheit, for a period of from one to two hours. This tempers the spring and prolongs its life.

The accompanying table was figured from a Kent formula and gives the outside diameter, which is indicated by *D*, the safe load, which is indicated by *W*, the deflection, which is indicated by *F*, and also the size of the wire. This table is for helical round wire springs and values for square wire springs may be easily computed by using the following constants:

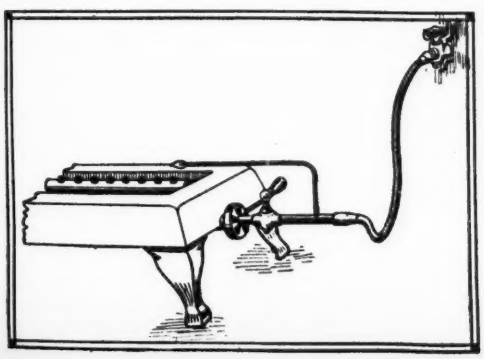
F in the table should be multiplied by .59 and *W* by 1.2 to find values for square wire.

Contributed by

F. B. ELLIOTT.

An Automatic Gas Lighter

An automatic gas lighter for a small gas heater which is turned on and off frequently, can be made by drilling and tapping the valve or pipe on the intake side of the heater valve, to accommodate an 8/32" machine screw. A piece of brass or copper pipe, ⅛" outside diameter, is threaded with an 8/32" machine die. This pipe is connected to the intake side of the valve or pipe, bent into the hole provided for lighting the heater, and extended until it reaches the first tip. A small flame can be had by denting the pipe with a pair of pliers.

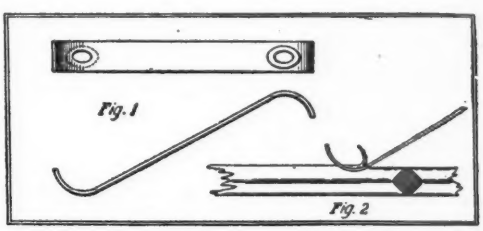


Contributed by

C. P. CLEARY.

Pattern Maker's Tool

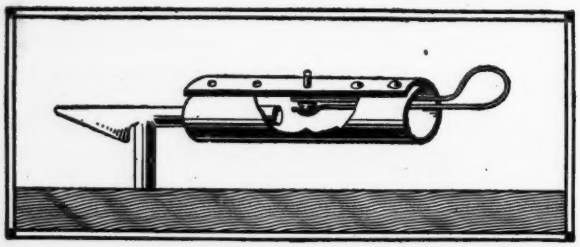
While walking through a factory the contributor noticed a pattern maker using a very handy tool. The device enabled him to round the edge of a pattern, taking off the corners a little bit at a time and with the greatest ease.



The tool was made from a piece of 1/16 inch strip steel about ¾ inch wide and 7 inches long. The strip was bent into a long "S" shape as shown in the illustration, and the two holes, one in either end, ground in the curved portion to form an elliptical opening with a cutting edge. The size of the hole determines the radius of the curve which is to be cut in the rounded corner of the pattern. It is, therefore, advisable to make up a number of the tools fitted with different sized openings in order that various classes of work may be accomplished. The method of using the tool is clearly shown in the illustration.

Contributed by

ED. HART.



A Rivet Holder

In riveting the seams of tubes having small diameters, considerable difficulty is usually encountered, because the rivets cannot be held in place. This can be overcome by using the tool illustrated in the accompanying drawing. A strip of stiff metal is bent in the center and notched at one end. The rivet is inserted in this notch and slipped into the desired hole in the tube and held firmly.

Contributed by

GEO. T. COOPER.

Babbitt Rivets for Mending Pans

Small holes in tinware can be mended with rivets made of babbitt metal in small slugs. The slugs should be inserted in the holes and flattened on both sides.

Contributed by

LEO M. LAFANE.

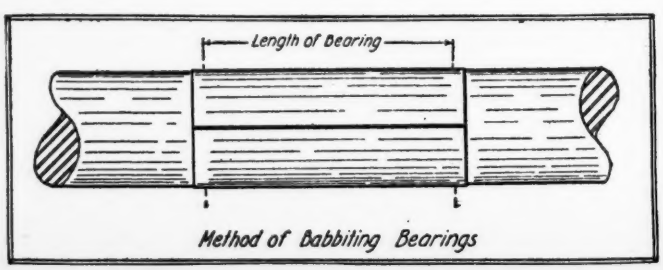
Method of Babbitting Bearings

The method suggested herewith for making a babbitt bearing has been used with great success. A short length of shafting is used for the babbitting mandrel, the diameter being the same as that of the shaft to be used in the bearing. A single thickness of newspaper is wrapped around the mandrel, the ends of the wrapping being cut square and made to meet as shown in the illustration. The ends of the paper are secured to the mandrel with thin glue or mucilage. The width of the paper should be somewhat greater than the length of the bearing to be poured, as suggested in the drawing.

The mandrel is set up in place and the babbitt poured in the usual way. After removing the mandrel, the bearing surface will be found to be smooth and clean; therefore, very little scraping will be required, as the paper-covered mandrel makes the bearing with just sufficient clearance to produce a good running fit.

Contributed by

JOHN LEAFSTROM.



Method of Babbiting Bearings

A Makeshift Die

A die to cut threads upon fibre or hard rubber bushings can be made from a nut having the desired sized hole and thread pitch. Four small grooves should be cut across the threads at equal distances apart.

Contributed by

CLARENCE H. ANDERSON.

Substitute For a Jack Screw

A 2/3 inch or 1 inch turnbuckle makes a very good substitute for a jack screw for leveling or raising light timbers, boilers, etc. The nuts on the ends of bolts should be set tightly with a lock nut or by welding to the shank of the bolt, so that the bolt cannot turn when it is placed against the object to be lifted.

Contributed by

T. N. SLOCUM.

Questions and Answers

THIS department will appear regularly in POPULAR SCIENCE MONTHLY AND THE WORLD'S ADVANCE, subject to following regulations: The questions must be legibly written with typewriter or in ink, on one side of the sheet. Each question must be definite and cover but one point of the subject under consideration although a letter can contain more than one question. On the 10th of the second month preceding the date of issue of the magazine all the questions on hand will be considered, and those which are put in the most intelligent manner and of widest general interest will be selected for publication in such issue, the number being governed by the space available. All other questions will be returned to the writers with a statement of the price for which they will be answered by letter. Return postage must be enclosed with each letter containing questions, and the letters must be addressed to the Questions and Answers Department and contain nothing relative to other departments of the magazine.

TESLA COIL.

(22) C. W. C., New York City, asks:

Q. 1.—I have constructed a ½-kw. Tesla coil and desire to use it with a ½-kw. coil type of transformer with a vibrator. I will use six Columbia dry cells. How many glass plates, each 8 in. x 10 in., coated with tinfoil 6 in. x 8 in., will it be necessary for me to use?

A. 1.—With the type of coil which you mention it will not be possible to use much over 8 or 10 plates.

Q. 2.—Would a 6-60 storage battery be better than the dry cells?

A. 2.—The storage battery would be far preferable if the voltage were higher. Use an 8-60 or a 10-60 battery.

Q. 3.—How large a spark should I obtain?

A. 3.—We doubt if it will be possible for you to obtain over a six-inch spark.

RECEIVING SET CONNECTIONS.

(23) R. S., Carlisle, Pa., asks:

Q. 1.—Is the enclosed diagram of connections satisfactory to use with a radio receiving set?

A. 1.—No. Omit the battery *B* and the condenser *C*. Place the detector where you now have the battery.

Q. 2.—I have been unable to receive anything with the set as shown. Can you suggest anything which might be the trouble?

A. 2.—Yes. We would not expect you to receive with the present connections. Make the changes indicated and all should be satisfactory.

Q. 3.—Is there any large station near Carlisle?

A. 3.—Arlington is sufficiently near so that you should hear them without difficulty. They send time signals at noon and 10 P. M. Also weather bulletins at 10 P. M. The wavelength is 2,500 meters.

TRANSMITTING SET

(24) C. C. H., Abington, Mass., writes:

Q. 1.—He gives a large amount of data regarding his transmitting set, the essential features of which are: Aerial 90 ft. long with 35 ft. lead in, 1 in. spark coil with suitable condenser, quenched gap, and helix of variometer type. He says that he can get but four miles, but with just his coil connected in the aerial circuit he can get ten miles, and that his wave is not sharp. He desires to know what the trouble is and how it may be remedied.

A. 1.—A small spark coil is very unsatisfactory when used in a tuned circuit. It has a high secondary voltage so that when put directly in the aerial circuit it is capable of radiating energy. But when so connected the damping is very high, due essentially to the high resistance of the gap. The radio law forbids high damping, or broad wave, so that it becomes necessary to use tuned circuits. The character of the secondary current and the small amount of energy of the spark coil available do not make satisfactory conditions of operation. Four miles is probably as good as you can expect to do with tuned circuits on a 1-inch coil. Your aerial has a natural period of 200 meters or over, so that you will find difficulty in complying with the law unless you use a series condenser, and you have too little energy already to do that. Better cut down your aerial a bit. The quenched gap is of no advantage to you with a spark coil. You will get just as good results, if not better, without it. There is very little you can do to improve your efficiency and remain within the requirements of the radio law.

WINDING OF THE STATOR OF AN INDUCTION MOTOR

(25) K. J., Canon City, Col., says:

Q. 1.—How to wind the stator for an induction motor for a speed of 3,600 rev. per min.,

to fit a 60-cycle 110-volt circuit? Stator sheet iron is 5 in. outside diameter, 3 in. inside, and the stack is 1¼ in. thick, and there are 24 slots.

A. 1.—If you mean to make the machine operate as an induction motor you will be limited to a speed of about 3,300 or 3,400. Of course, the smallest possible number of poles is two, and while 3,600 rev. would then be the synchronous speed, the actual speed would be a few hundred less. If you prefer a series motor, requiring an ordinary direct current motor and commutator, you can get 3,600 rev. or more. In either case the stator would be wound for only two poles, but the amount of iron in the particular lot you have is insufficient for that magnetic arrangement, for the outside diameter should be about 1 in. more than at present. To make the case worse, the space lost by use of rivet holes is to be regretted. The best alternating current motors avoid this construction. If you utilize these holes be sure to use brass, not iron, bolts. To wind for two poles you can adopt hand-wound concentric coils or form wound over-and-under coils. In either case see if you have room for them within the frame. For the first sort wind a coil, say of No. 22 wire, filling slots 6 and 8, ignoring 7; then without cutting the wire, continue into slots 5 and 9; similarly in 4 and 10, 3 and 11, 2 and 12; finally a coil occupying half of slots 1 and 13. Opposite this group wind in similar manner a coil in slots 18-20, 17-21, 16-22, 15-23, 14-24, and a half coil in 1-24. If wound in exactly the same manner, the two inside ends are now to be connected together, the other two lead to terminals. The magnetic effect can be tried with direct current, the central teeth in one group being energized to a greater strength than those near the outer coils, the two groups being of opposite polarity. The second method involves placing coils in slots 2-8, 3-9, 4-10, 5-11, 6-12 and 7-13. The other group occupies slots 14-20, 15-21, 16-22, 17-23, 18-24 and 19-1. This method is frequently adopted in "universal motors." If you will be satisfied with the induction motor operation, the rotor can be of the squirrel-cage sort.

SECRECY OF RADIO MESSAGES

(26) R. O. S., Polo, Ill., asks:

Q. 1.—Would two No. 10 copper wires be equal to 1 No. 4 for a protective ground for a radio set?

A. 1.—No. It would be necessary to use 4 No. 10 wires to get the equivalent of 1 No. 4.

Q. 2.—Would an ordinary telegraph key fitted with dime contacts carry the current from a 1 kw. transformer?

A. 2.—Yes.

Q. 3.—Is it lawful to have a bulletin board for the purpose of printing the press news and weather reports that are sent out by Arlington (NAA) at 10.00 P. M. eastern time? This is to help inform the public that I have established radio reception from Arlington, and communication between neighboring communities.

A. 3.—It is lawful to publish such news as is sent broadcast for the reception and publication of all who hear it. The weather reports and such allied matter may be published, but care should be taken not to publish anything sent to an individual station or group of stations. Press from WCC cannot be published.

Q. 4.—Does the length of ground lead cause a decrease in efficiency?

A. 4.—Yes.

Q. 5.—Is it advisable to use a variometer for long distance receiving?

A. 5.—Variometers are very little used at the present time.

WINDING FOR DYNAMO ARMATURE

(27) F. B. R., Reading, Kansas, asks:

Q. 1.—What would be the proper winding for a 40-slot drum armature 5¾ inches in diameter and 3 inches long to yield a pressure of 12 volts? Slots are ¼ inch by ⅜ inch.

A. 1.—As you did not state what speed was desired, we shall have to suggest one, say 1500 r. p. m., but if you prefer a slower speed, it can be arranged for by proportionately increasing the number of conductors. The size of slots proposed does not yield the maximum output, and the slenderer are the teeth the more effectually are the armature reactions, therefore the sparking, prevented. It will be an improvement to increase the depth to ⅝ inch, but if required, the width of slots could be reduced to .23 inch. Form wound coils will be used on armature, arranged for a four-pole field magnet. Let each coil consist of two turns of two No. 11 wires in parallel, giving four wires per coil, eight per slot. Woven-wire copper brushes in four places on the commutator will be necessary, and the allowable current will be between 125 and 150 amperes. Each pole shoe should have an arc of about 3¼ inches, and the cores on which the spool fits be of wrought iron about 2½ inches in diameter, with a winding space 2¼ inches long. The magnetic yoke can be of cast iron of 5 inches by 1¼ inch section.

CONNECTIONS OF SQUIRREL CAGE ROTORS.

(9) F. P. A., Lincoln, Neb., asks:

Q. 1.—Why is it that same three-phase induction motors with "wound" rather than squirrel-cage rotors have the "Y" point of these windings grounded, while others do not?

A. 1.—For one reason it makes a convenient starting point for the windings, otherwise a special copper ring is necessary. For a more important reason, it diminishes the potential difference between windings and core. At the moment of starting, there is induced in

the rotor, in spite of the few turns in such coils, a fairly high voltage. Without the grounded center there would be the voltage due to two phases in series, but as thus definitely attached to the iron, the voltage is that of one phase only. The same principle is recognized in ordinary three-wire direct or alternating current distribution systems from central stations, whereby only half the working pressure is exerted between a line wire and the ground, thereby diminishing personal danger.

SPARK COILS

(28) M. C. O., Castle Rock, Colo., asks:

Q. 1.—I am 28 miles from Denver, 45 miles from Colorado Springs, and 85 miles from Pueblo. How many 6-60 storage batteries and what size spark coil would it take to reach to each of those places? There is no light plant or electrical power nearer than Denver.

A. 1.—For Denver you would require at least a 5-inch coil. Such a coil would probably be wound for about 20 volts. This means that you would need 3 sets of 6-60 batteries. To reach to Colorado Springs you would need an 8-inch coil. A 60 storage battery would be a little small for the coil, but if specially wound for high primary voltage it might be possible to use 60s. We would expect to use about 4 6-80s on it. To reach Pueblo you would need at least a 10-inch coil. You would require 5 6-120s to run this coil. On these figures of coils we have not allowed a very large factor of safety. Signalling by coils will be found to be expensive. Before actually building your set it would be best to go into the matter in great detail, for if you do not you are pretty apt to meet with an expensive failure.

Q. 2.—Where can I get information on the audion?

A. 2.—Consult the back numbers of this magazine. If you have not a copy of the index one will be furnished you on request for the period desired. There have been several good articles during the past two years.

RADIO REPORTS

(29) E. L., Clarksburg, W. Va., asks:

Q. 1.—Will you please tell me at what time in the evening Sayville, Cape Cod and Key West radio stations send their reports?

A. 1.—Cape Cod (WCC) sends press at 10.15. It takes about 45 minutes for the complete copy. A break of 15 minutes is then given and the same matter sent the second time. A second break of 15 minutes follows and the matter is repeated for the third time. Sayville has changed its time since the war broke out. Formerly they started at about 9.15 on 2800 meters. Now they start at 11.00 on about 4000 meters. Key West waits until Arlington gets through with the report which is sent at 10.00 and then they send the same report as sent out by Arlington.

ELECTROMAGNET WINDING

(30) A. E. K., Mobile, Ala., asks:

Q. 1.—What would be the dimensions and winding for an electromagnet capable of lifting a weight of 75 pounds, the energy to be taken from a 10-volt 8-amp. dynamo?

A. 1.—It is not difficult or expensive to make a magnet that will hold 75 pounds, but quite a different case if the distance through which the magnet is to work be even a fraction of an inch. A U-shaped piece of 1-inch diameter round iron would readily suffice to do the holding, and with less expenditure of electrical power than you have proposed, but if the lifting is to be across an air gap, we would need to have the conditions stated in a definite manner.

CONVERTING A MOTOR INTO A GENERATOR

(31) A. R., New York City, asks:

Q. 1.—What would be the proper winding for a Diehl 1/7 h.p. motor to change it into a 6-volt generator for charging storage cells? Field bore is 2 5/16 inches, diameter of armature 2¼ inches, length 1¾ inches, with 16 slots and 16 commutator segments. Its present winding yields a speed of 2800 rev. when operating as a 220-volt circuit.

A. 1.—To give 8 or 9 volts on open circuit, or 7.5 volts when desired for charging the cells, you will require about 12 wires per slot, or 6 per coil. This number will permit a reduction of speed from that stated; as for a low voltage generator, necessarily requiring copper brushes, the speed should be kept as low as possible. As you did not specify the size of slots, we cannot decide what is the largest permissible size, but you can readily determine that for yourself. Field wire should be about 25 times as large as at present, which, in the B. & S. wire gauge, means a number about half as large. For instance, if present wire is No. 30, you can substitute No. 16.

Q. 2.—What size of water motor to use, if operated at city pressure?

A. 2.—As you do not state the pressure in pounds we cannot decide. You may be in the basement or the attic, and the difference in pressure will be considerable. In any case, you will find operation from such a source very expensive.

RECEIVING SET CONNECTIONS

(32) W. W., Whiting, Ind., asks:

Q. 1.—What is the best connection for the following instruments? Receiving transformer, detector, loading coil, variable condenser, fixed condenser, 2000 ohm head set. My aerial is 50 feet long.

A. 1.—Connect the aerial to the loading coil, from the loading coil to the primary of the receiving transformer, and from the receiving transformer to the ground. This is known as the primary circuit. If the loading coil is not already provided with a switch for

cutting it out when not in use some form of switch must be added. Use a two point switch. Connect the aerial to the handle, or middle contact, then from one contact go to the loading coil and from the other contact go to the receiving transformer. The open end of the loading coil also goes to the receiving transformer. This method actually cuts out the loading coil when not in use and does not merely short circuit it the way that is so often incorrectly done.

Connect the variable condenser directly across the secondary of the receiving transformer. From one side of the variable condenser go to the detector, from the detector to the fixed condenser, and from the fixed condenser back to the other side of the variable condenser. The phones go directly across the fixed condenser. This circuit, made up of the secondary of the receiving transformer, the two condensers, the detector, and 'phones, is known as the secondary oscillation circuit.

SPARK COILS

(33) W. B., Fredericktown, Ohio, asks:

Q. 1.—Is there any way that I can connect up a 1-inch, 1½-inch, and a ½-inch spark coil so as to get a 3-inch spark?

A. 1.—No.

Q. 2.—Will a gravity battery light a miniature lamp?

A. 2.—Because of its high internal resistance a gravity battery is not suitable for lighting lamps.

Q. 3.—How many leyden jars should be used in connection with a 3-inch coil?

A. 3.—This would depend entirely on the size of the jars, and for what purpose the coil was being used. For general work something in the order of four jars would probably be used. This assumes two quart jars.

Q. 4.—Does the capacity of a leyden jar depend on its size?

A. 4.—Most certainly. The capacity increases directly with the surface area coated with foil.

Q. 5.—Can copper plates be used in making a variable rotary condenser?

A. 5.—Yes, but it is not as satisfactory as aluminum plates because copper is not as rigid as aluminum.

Q. 6.—Under what conditions can I use a helix with a 3-inch spark coil?

A. 6.—If you can get a sharp wave with it. But it is next to impossible to obtain a sharp wave with a helix. If no other station is within range of your station you can use a helix as long as this condition exists.

WINDING FOR A LOW-VOLTAGE DYNAMO

(34) E. B. K., Portland, Ore., asks:

Q. 1.—What should be the winding of a dynamo to give 10 volts when driven at a speed of 2500? Dimensions are as follows: Rectangular cast iron field, 2.5 inches wide, ⅝ inch thick; two poles with winding space 1¾ inch diameter and 1½ inch long, bore being 2¼ inches; armature has 12 round holes, each 7/16 inch in diameter.

A. 1.—We urge enquirers always to send a sketch of a proposed dynamo, the designations in words frequently being vague. For instance, a "rectangular" field magnet may have several shapes; we will take it to be "iron-clad," having iron both above and below armature, and the two poles having a common axis. An important designation, the diameter of armature, you omitted. We will assume air gap is not over 1/16 inch on each side of armature. With these suppositions, the field ought to supply 100,000 useful lines of force, and at the speed you give, allowing for various losses, 32 conductors per slot should suffice, and you ought to get in this number using No. 17 double cotton covered wire. Instead of using a 6-segment commutator you ought rather to have a 12, and still better a 24, else there will be considerable sparking. Of course the six will be tolerable, but not good. For shunt field you can use about 2 lbs. per spool of single cotton covered No. 20 wire.

DIMENSIONS OF 110-VOLT GENERATOR

(35) H. S., Athens, Ohio, asks:

Q. 1. Are the following dimensions proper for a 110-volt 9-ampere dynamo:

Cast iron yoke 16 inches outside diameter, section 6 inches by 1 inch; four poles cast integral with yoke, each having a section 3½ inches by 3 inches, 3¾ inches long, to be bored out 6⅛ inches. Armature 6 inches in diameter, 3 inches long, with 24 round holes, each ½ inch diameter, commutator with 24 segments.

A. 1.—While the proportions are fairly good you have underestimated the output of the machine. Assuming a speed of 1500 r. p. m., you require about 48 wires per slot, and with due allowance for insulation you ought to get them in if you use No. 17 d. c. c. This size is good for 4 to 5 amperes, and since the winding gives the effect of four wires in parallel, you will be able to get 16 to 20 amperes in all. Sparking will be reduced if you use a 48-segment commutator, winding two coils per slot, that is, after every 12 turns bring out a lead to the commutator. The entire length of the pole pieces as you have sketched them will not be available for wire, and the appearance will be greatly improved by filling in the pattern with a flat pad for each coil to rest upon. Use 6 lbs. per spool of No. 21 s. c. c. wire. You can still further improve the appearance and operation of the machine if you follow the design for one of almost these dimensions made by our Mr. Watson, in the electrical engineering laboratory of Brown University. Separable pole pieces are used, liberal self-oiling bearings, etc. If interested, we will be glad to advise your further.

RADIO SECTION

Devoted to the Encouragement of Amateurs and Experimenters in the Field of Radio Communication

Wireless in the Dark Continent

By M. E. Pelgrims

WIRELESS is rapidly invading the most remote corners of the earth. In the French colonies of Central Africa, near Lake Tchad, seven wireless stations are in daily use, operated by the French government. In 1911 it was decided by the French Minister of Colonies, M. Messiny, to connect the military territory of Tchad with Ouadai. As it was impossible to run wire lines between the two territories because of the dense vegetation, the wild animals, the high cost of the miles of wire required and, most important of all, incessant wars with the natives, wireless was chosen as the most practical means of communication.

A section of Central Africa where wireless telegraphy is depended on as the sole means of rapid communication with the outside world.

It was no easy task to install the radio stations. The engineers decided to install six stations separated anywhere from 125 to 200 miles apart and scattered throughout the Tchad district. The stations were finally built at the following points: Nguigmi, Mao, Mussoro, Ati, Abeshr, Faya and Fort Lami.

The first difficulties were encountered when the party, consisting of Captain Chaulard, head of the expedition, a Captain of the Colonial Artillery and ex-chief of the radio service of Madagascar, a lieutenant and twenty-five men of the signal corps, were disembarked on the African coast and had to start on their difficult journey through the tropical forests. All of the apparatus had to be carried on men's backs for hundreds of miles. Later on in the journey, oxen and canoes were used on land and water to carry the materials and apparatus. The party had to be divided into two separate parties, one going by way of Lagos (Nigeria) and Zinder, the other through French Congo, Oubanghi and Chari.

The stations to be installed consisted of two steel masts ninety feet high, a five-horsepower kerosene motor driving an alternating current generator of one thousand cycles frequency, .05 mfd. condensers, and musical notes spark gap, and other pieces of apparatus, all of which were packed in steel waterproof boxes of about 155 pounds each. One night the tent of the party was flooded and upset, and on more than one occasion they were seriously annoyed by the wild animals of the jungles.

Then came the technical troubles. The sets were first tuned to a 1,500-metre wave length but the results were very poor, only 95 miles being covered. The wave length was lengthened to 3,500 metres and 10 feet more added to the masts. This resulted in increasing the range to a trifle over 400 miles. At the present time the Fort Lami station communicates regularly with Abeshr, a distance of about 300 miles. The constructors were also handicapped by the impossibility of securing a good ground connection at first. Finally, one of them conceived the idea of burying the steel boxes in which the apparatus had been packed and connecting the ground wire to them. This proved to be an ideal ground and the results were still more satisfactory.

The conquered wilderness soon avenged itself upon the invaders. The men were stricken by the malarial fevers and the lieutenant and several of the men had to be sent back to France in order to save their lives. Captain Chaulard and the other engineers, however, struck to their posts and while the other men were helplessly ill, he, shaking with fever himself, kept in constant communication with the other stations. This self-sacrifice nearly cost him his life on two occasions, but his courage inspired the other men, and some time later they succeeded in establishing the seventh station 250 miles northward, thus connecting Borkoo with Ouadi. Later on, when he was able to communicate between Faya and Fort Lami, a distance of about 454 miles, the French government decided to award him the Legion of Honor decoration in recognition of his services.

In this manner has the French Signal Corps invaded into the darkest corners of Africa and established wireless stations which permit of communication with the outside world. The courage and perseverance they have shown is typical of wireless men the world over.

A High Tension Battery Switch for Audion Circuits

IT has been long acknowledged that in the telephone-grid circuit of an audion detector, adjustment of the high-tension voltage is necessary, as all bulbs do not act alike, and the same bulb is found to work different under varying conditions. In order to provide for this adjustment it has been customary to employ an ordinary point switch, the lever of which is connected to one side of the circuit and the points connected to consecutive plates of the high-tension battery. Now in such an arrangement it is quite apparent that if the points are set close together or the switch lever which rides over the points made wide enough to span two consecutive points, then, if great care is not always taken to see that it is in contact with only one point at a time, the current from one cell will pass from its point across the lever to the next point, thus short-circuiting one cell and destroying its usefulness.

The only method in use within the writer's knowledge to prevent such short-circuiting of cells has been to separate the points so far and to make the switch so narrow that no bridging could possibly occur. This method is, of course, quite effective, but, owing to the fact that the lever must ride down into the space between each pair of points and up over each point, this type of switch is open to the objection that it is difficult to adjust, noisy, and, owing to the unusual distance between the points, is not as neat in appearance as might be desired.

In the construction of an audion cabinet the author was confronted with this problem and solved it very successfully in the manner about to be described with the aid of the accompanying drawings.

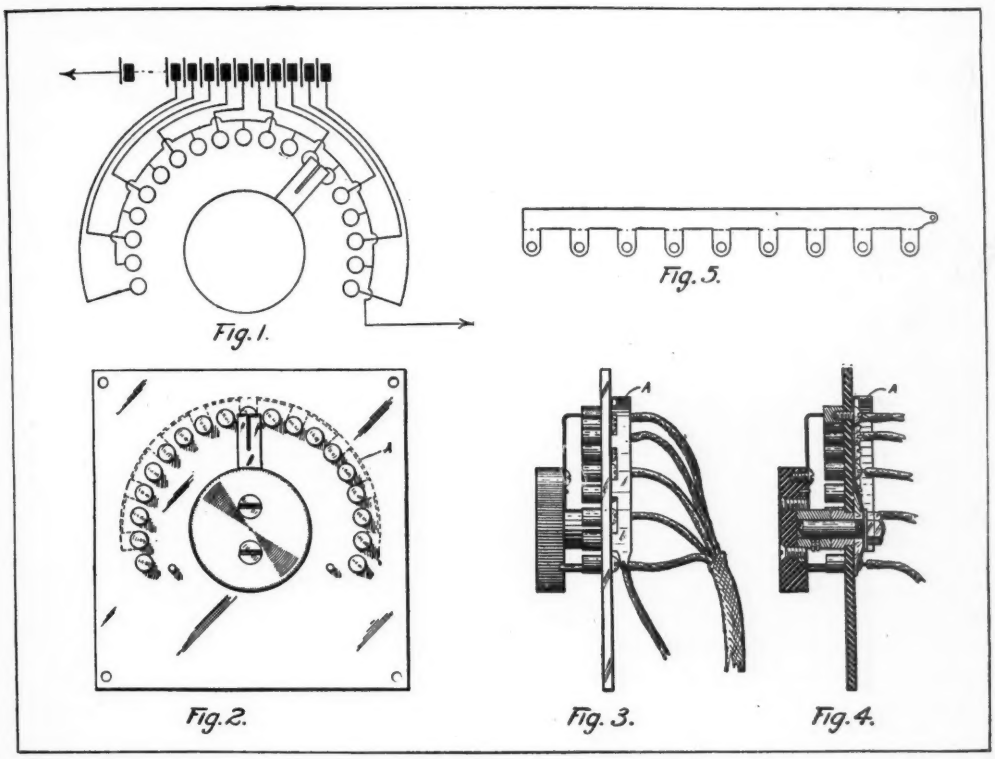
In Fig. 1 there is given a diagram of the connections used on this switch, and there is diagrammatically shown the method employed. It will be at once

noted that between the switch points of the ordinary switch there are interposed other points, the space between all the points being equal and but 5/16 inch when using ¼-inch points. These extra points are all connected together at the back of the switch panel, and take the place of the usual conducting arm and connection to the center of the same. In this case the switch arm acts only as a bridge between any two points selected. Thus, connection to any cell of the high-tension battery is obtained by placing the switch arm in such a position that the point connected to that cell is connected to the adjacent point through the arm. This in brief is the method employed. It is, of course, evident that in such a switch the cell terminals can never become crossed and also that as the switch arm does not enter the spaces between the points that a perfectly smooth riding switch is obtained.

Fig. 2 shows to scale the appearance of the switch, this particular model employing ten live points and nine common points.

Fig. 3 is a side elevation of the same and shows how the common points are joined at the back of the panel by means of the brass strip, *A*. This strip is shown in detail in Fig. 5. The strip is cut from a piece of thin brass as shown and the little tabs bent up at right angles, after which the tabs are fastened under the heads of the switch point screws, as clearly shown in Figs. 3 and 4.

Fig. 4 is a section taken on the line of vertical centers of the switch in order to disclose the construction of the switch lever with its hard rubber handle, and also the method of attaching the lead wires to the live points. Into the kerf of the fastening screws at the back of the switch points is drilled a small hole just large enough to take the cleaned and bared end of the lead wire, which is inserted in the hole and soldered in



Constructional details of a high tension switch for audion circuits, as well as the wiring scheme used in conjunction with it.

with the aid of a small blow torch and suitable soldering paste. The soldering can be done before the points are fastened on the panel if a screw driver is first provided having a notch through the center of its edge to accommodate the wire. If, however, the rubber panel is thick and the soldering is done quickly there is no danger in soldering such leads after the switch is partly assembled.

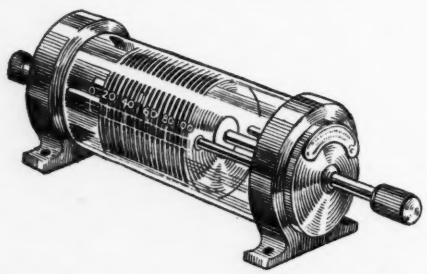
In order to construct this switch within reasonable limits as to space and yet give it as neat an appearance as possible, it is necessary to use a type of switch point that has a hole at the rear for a machine screw. The ordinary switch points now largely used have a threaded shank and nuts at the back which take up too much space.

Contributed by

CHAS. HORTON.

A Variable Condenser of New Design

There has recently been perfected by Eugene T. Turney, an inventor of New York City who has a number of wireless inventions to his credit, a variable



This variable condenser is operated by pulling or pushing the rod protruding from one end.

condenser that combines a large capacity, compactness and ease of operation.

The new condenser is not of the common intersecting plate type. Instead, there are a large number of plates separated by air spaces and so mounted that they may be moved as a single unit on two brass rods. One of the brass rods is insulated from the plates by means of an insulating bushing, while the other makes contact with the plates. The plates are placed on two carrying rods with the holes in a staggered position in relation to each other, so as to make them alternate in their point of contact. The supporting rods are for part of their length made of insulating material, while the remainder is brass. As the plates are drawn over the insulated portion of the rods, more capacity is procured. When the plates are moved in the opposite direction so as to bring them on the brass portion of the rod, they are short-circuited, reducing the capacity.

The capacity of the condenser is determined by the proximity of the plates, which in turn is controlled by the thickness of the spacing washers between the plates. The capacity can be increased without enlarging the size of the plates, by using thinner washers between them. Owing to the peculiar construction of the instruments, the plates may be placed extremely close together, thus securing a comparatively high capacity. This condenser, made with thirty-five plates, has a capacity of .00046 mfd., while another of fifty plates spaced closer together has a capacity of approximately .002 mfd.

Among the advantages of the new condenser may be mentioned the fact that it is impossible for it to get out of order. The plates cannot short-circuit, and the case, being both air- and dust-proof, prevents dirt from hampering the efficiency of the instrument. Sliding the plates on the rods causes the latter to be clean at all times and thus insures perfect contact. The instrument is graduated by a scale etched in the glass casing. All electrical connections are broken when the pointer sets at zero, giving this condenser an absolute zero.

The newest and oddest use of a dry battery is the electric horsewhip. The whip is supplied with two metal rings. When these are laid against the horse a current causes a mild shock, which, the inventor claims, "will materially accelerate the speed" without injuring the horse.

The Non-Synchronous Rotating Gap

By A. S. Blatterman, B. Sc.

IN *Electrician and Mechanic* for October, 1912, the writer has already discussed the rotating gap, presenting a general theory to account for its action, and proposing with the aid of one or two elementary equations an explanation of some of the effects of rotative speed, capacity values and voltage. It was pointed out at that time that the size of the condenser was an important item in the most effective working of the gap, and in general it appeared that the correct value was considerably less for a given transformer when a rotary gap was employed than when a plain stationary gap was used. The writer's statement to this effect was met by some criticism at that time, though now its truth is generally admitted, and it is a point in fact that the most effective spark sets of the type under consideration are now using condensers considerably smaller than would be necessary if stationary gaps were used. The question of sparking rate was also discussed.

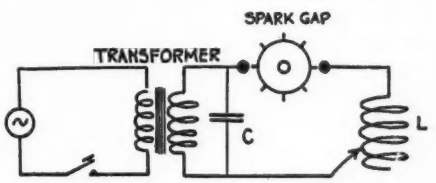


FIG. 1.

A simple transmitting circuit in which a rotary gap is employed

It appears, however, that a great deal more remains to be said concerning the factors, capacity and speed, and their effects upon power, antenna current and radiation, than was evident at the first writing. The production of smooth spark tones alone is important as well as very interesting, and it is a matter of general experience among all those who have used the non-synchronous rotary that certain motor speeds produce clearer sparks than others.

Where the cycle of primary current is of low frequency, that is, 25 to 133 cycles, the advantages of a high spark rate with musical tone can be achieved by using for the spark gap a device which breaks up the wave of voltage from the inductor or transformer into several sparks per alternation. A common form of spark gap for this purpose consists of a metal disk, rotated at high speed, which carries a number of equally spaced studs about its periphery and which revolves between stationary electrodes. The usual arrangement of the gap and its position in the circuits is shown in Fig. 1.

The device differs in its operation and to some extent in its purpose from the so-called synchronous rotating gap. In the latter the disk is rotated at a particular speed such that the r. p. m. multiplied into the number of studs on the disk is equal to the number of alternations per second of the primary alternating wave; and then the stationary electrodes are mounted on a frame so that they can be rotated about the disk after the manner of the brush-rocker on a dynamo, and thus cause stationary and revolving electrodes to come opposite each other for sparking at the instant when the alternating wave is passing through its maximum. Thus, one spark is obtained in each alternation of the voltage cycle, and it can be made to take place at the maximum value of voltage in the cycle. To secure and maintain the synchronous relation of spark disk to primary wave, the disk is mounted on the shaft of the generator which supplies power to the transformer. To secure the desired high spark tone the spark gap, transformer and generator are designed for a primary wave of high frequency, commonly 240 or 500 cycles, which give, respectively, spark rates of 480 or 1,000 per second. The transformer, theoretically at least, is adjusted to the condenser so as to produce a condition of resonance for the frequency employed.

* Owing to the great length of this article it has been found necessary to run it in several instalments. The continuation of the discussion will soon appear.

That is, if L represents the inductance of the transformer in henrys, and C the capacity of the condenser in farads, then, roughly, adjustments are made to make

$$2\pi fC = \frac{1}{2\pi fC}.$$

In practice the adjustment is made for a condition of 15 or 20 per cent.

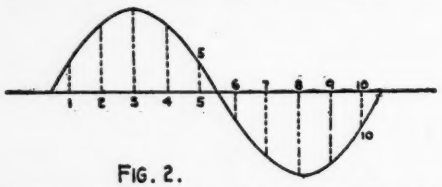


FIG. 2.

An alternaton of the current secured with a high speed, non-synchronous spark gap, indicating the instants of sparking.

below resonance. Thus, if resonance is obtainable at a speed of 1,500 r. p. m., the operating speed will be set at, say, 1,300 r. p. m.

With the non-synchronous rotating gap, on the other hand, the disk is revolved at high speed, generally without regard to the frequency of the primary wave, and instead of obtaining one spark per alternation at a constant voltage, the voltage wave is broken up into several sparks occurring at no very clearly defined instants during the alternation, though one particular conditon may be that shown in Fig. 2 where 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 indicate instants of sparking.

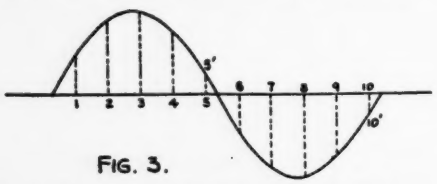


FIG. 3.

An alternation of the current secured from a rotary gap when the electrodes are not spaced at the critical length resulting in only four sparks per alternation.

The condition for sparking is that the instantaneous value in the wave shall be sufficient to break down the gap between stationary and moving electrodes when these come opposite each other. If, as is entirely possible, a pair of moving electrodes comes opposite the side electrodes at an instant when the voltage in the alternating wave is not sufficient to break down the gap or when the voltage is passing through its zero value, then the regular sequence of sparking will be broken, and one, two, three or more studs may pass the stationary side electrodes before the voltage has reached a value sufficient to cause a spark. Important factors are the number of studs on the disk, the length of the spark gap between moving and stationary studs, and the size of the condenser.

If the spark gap is made long by drawing the side electrodes back from the disk, then a considerable voltage will be required to produce sparking and thus only a few sparks will be obtained during an alternation. Some of the moving studs will come opposite the stationary studs without sparking, because they do come opposite at instants in the alternating wave when the voltage is too low to bridge the gap; and the greater the number of moving studs, or the greater the rotative speed of the disk, the greater will be the number of inactive studs during the cycle. If, however, the gap is made very short, as short as is mechanically possible, then a very low voltage is all that is required to break down the gap, and hence the condition may exist that sparking takes place to every movable stud as each pair in turn is presented to the stationary electrodes.

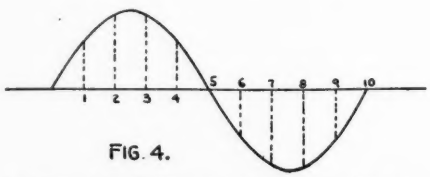


FIG. 4.

An alternation of the current secured with a rotary gap under certain conditions and when one stud is rendered inactive.

The maximum possible spark length—to take the case which is shown in Fig. 2—which can be used and still permit sparking to each stud, is that corresponding to the voltage at instants 1, 5, 6, 10, where now the division points 1, 2, 3, 4, etc., must be interpreted as denoting instants when moving and stationary studs are opposite one another in a position suitable for sparking.

When the gap length is longer than this every stud will not yield a spark.

When it is shorter each stud *may* still yield a spark.

When the gap is set at the critical length every stud will yield a spark ONLY WHEN MOVING STUDS ARE PRESENTED TO STATIONARY STUDS AT INSTANTS WHICH DIVIDE THE ALTERNATION SYMMETRICALLY AS SHOWN IN FIG. 2. For if the instants of opposite position, which will hereafter be called the sparking position, of moving and stationary studs are displaced along the cycle as shown in Fig. 3, then at instants 5 and 10 there is available only a potential 5-5′ (=10-10′) to break down a gap whose length is set for the potential 5-5 (=10-10), see Fig. 2, and hence instead of five sparks per alternation there will be only four. One stud has become inactive. If the gap is shortened now to allow discharge at voltage 5-5′ then all studs will again yield sparks, and the shorter the gap is made the greater is the permissible displacement of instants 1, 2, 3, 4, 5, etc., along the cycle.

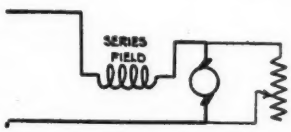


FIG. 5.

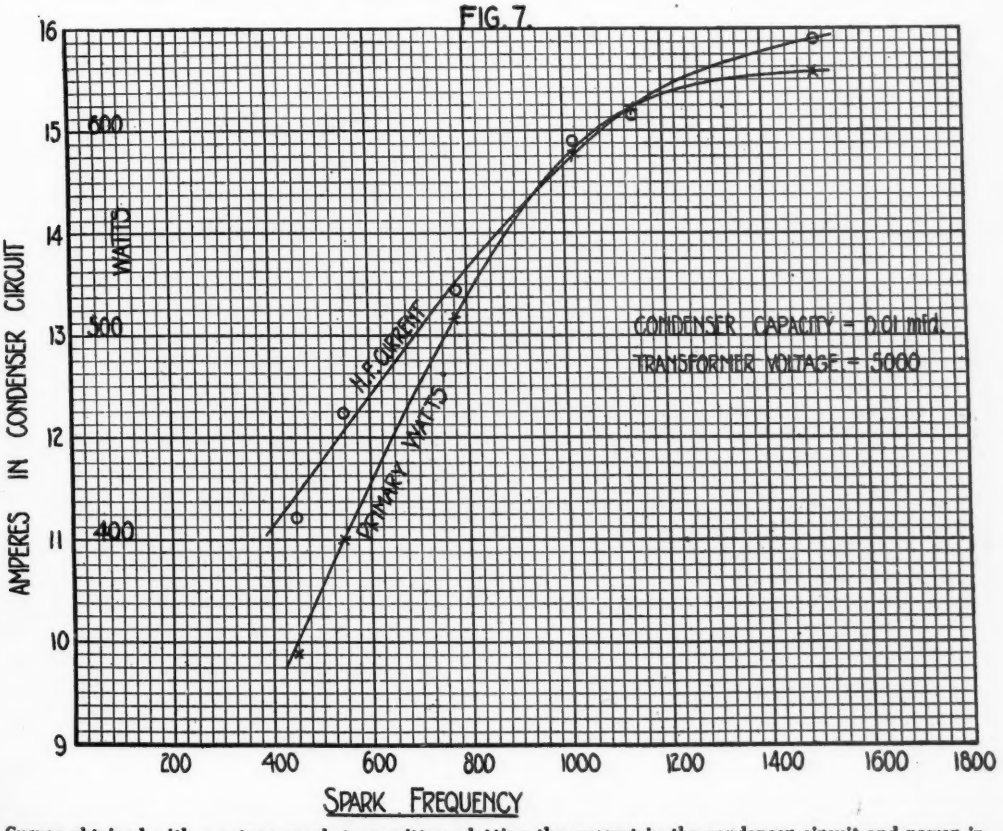
A water resistance shunted across the armature of a motor for securing low speeds.

When the displacement is such that the instants 5 and 10 of the representative case coincide with instants of zero voltage in the alternating wave then, of course, one stud will be inactive. See Fig. 4.

If the above reasoning is correct we must conclude that when the spark gap is very short there are two ways in which sparking may occur.

1. In every alternation each stud may yield a spark, in which case the sparks will follow each other at equal intervals.

FIG. 7.



Curves obtained with a rotary spark transmitter, plotting the current in the condenser circuit and power in watts in the primary against the spark frequency.

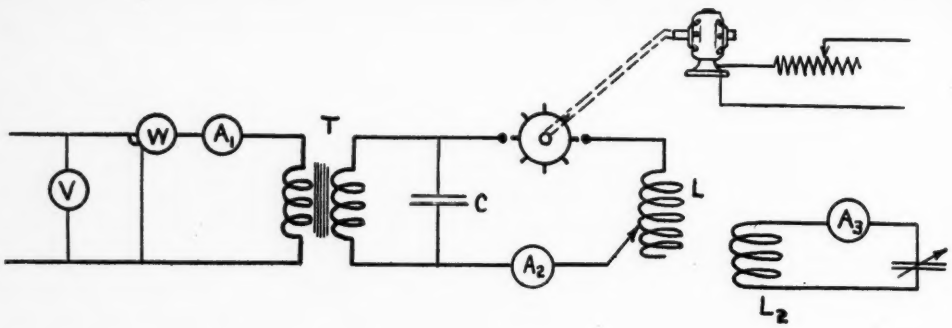


FIG. 6.

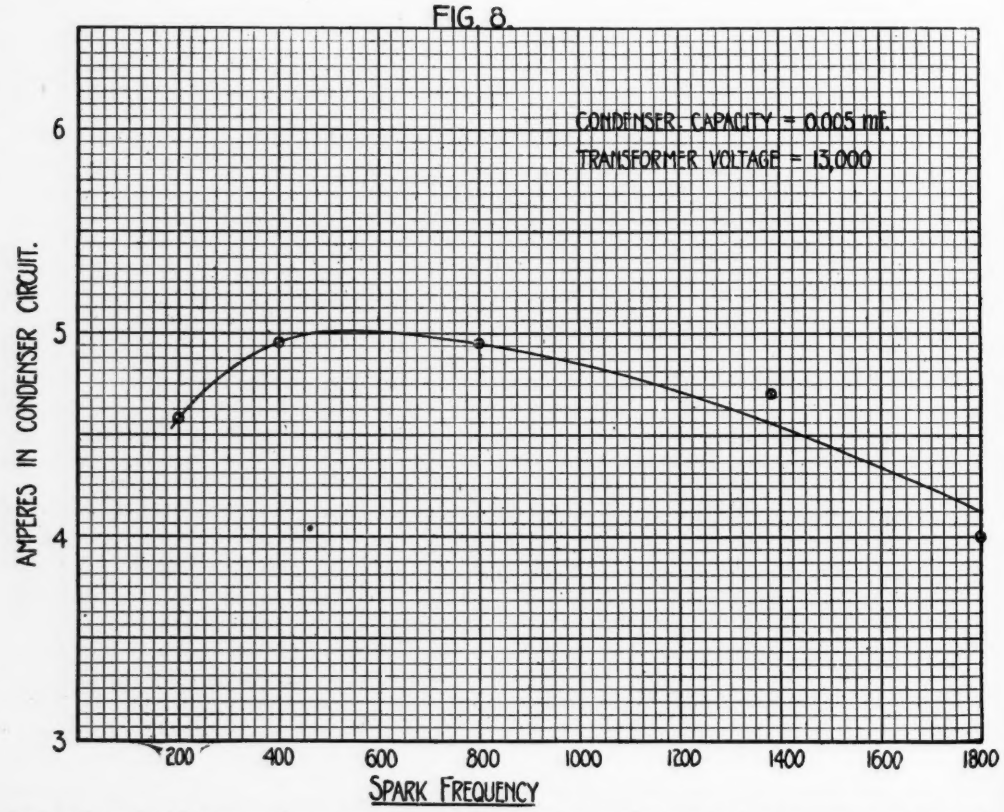
Arrangement of the various pieces of apparatus with which the author of this article obtained the data on rotary spark gaps.

2. In every alternation each stud BUT ONE may yield a spark, in which case sparks will occur in groups, the time interval between groups being twice as great as that between sparks in a group.

We must expect, also, if sparking occurs in either the first or second way just described, that the length of the gap must be less as the speed of the disk is increased, while at lower speeds it should be possible to use longer spark gaps.

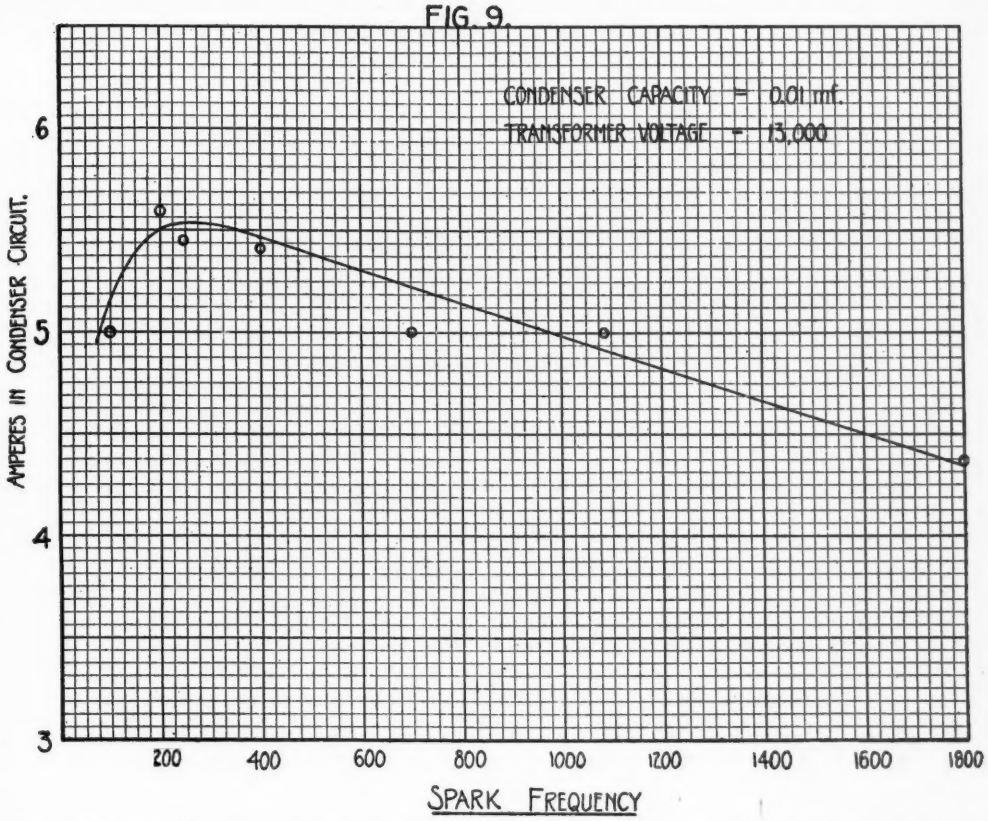
Experience has shown that these ef-

FIG. 8.



Curve obtained with a transmitting set using a rotary gap in conjunction with a condenser of 0.005 mf.

FIG. 9.



Curve obtained with a transmitting set using a rotary gap in conjunction with a condenser of 0.01 mf.

fects do exist. When the disk is rotated at high speed the spark gap must be made very short to produce anything like a smooth tone; and lengthening the gap by as little as 1/64" is often found to give the spark tone a very ragged quality, apparently indicating that a number of studs miss spark. On the other hand, when the disk is rotated at low speed the allowable spark gap is found to be much longer.

General experience has also shown that the rotative speed of the gap as well as the size of the condenser has important effects on the power and aerial current, and in order to investigate this the following experiments were carried out.

For the first experiments a small 60 cycle, 5,000 volt transformer was used. The spark gap was of a common type consisting of a disk carrying 18 studs. The motor was an a. c. series motor whose speed could be varied through a range of 500 r. p. m. to 5,000 r. p. m., the lower speeds being obtained by adjusting a water resistance placed in shunt to the armature (see Fig. 5); the higher speeds were obtained by giving the brushes a considerable lead. Instantaneous values of speed were read from a tachometer, the speed counter being found unsuitable except at the highest speeds. In this way the speed could be kept quite constant for any set of readings.

An adjustable glass plate condenser of maximum capacity 0.01 mf. was used. The high-frequency inductance was of copper strip wound in a flat spiral. The set-up is shown in Fig. 6.

An ammeter, A_1, voltmeter V, and wattmeter W, were placed in the primary side of the transformer. In the high-frequency circuit was placed a hot-wire ammeter, A_2. As the maximum range of this meter was only 8 amperes it had to be used with a shunt and calibrated for the wave length used. The calibra-

tion was effected by sending with reduced power and observing the reading of the meter without the shunt and then with the shunt connected. The ratio of the two readings then gives the multiplying value of the shunt. For observing wave length and decrement in the high-frequency circuit the wave meter inductance L_2 was loosely coupled with the condenser circuit and observations taken by means of the hot-wire milli-ammeter in the wave meter circuit. A preliminary set of readings was obtained with the speed as independent variable. See Table 1.

TABLE 1

Motor Speed r.p.m.	Spark Freq. N.	Primary Watts	H. F. Current Lamps
1500	450	345	11.2
1800	540	400	12.2
2600	780	510	13.4
3400	1020	590	14.9
3800	1140	610	15.2
5000	1500	630	15.9

Current in the condenser circuit and power in watts in the primary were plotted against spark frequency. See Fig. 7. It was found that with the higher spark rates the condenser current and power increased at a slower and slower rate toward what appeared to be a maximum.

This was interesting, and steps were at once taken to see if the curves did pass through a maximum and then fall as the motor speed was carried to very high values.

The 5,000,-volt transformer was replaced by one wound for 13,000 volts, and a new spark gap installed having twelve points, whose speed could be accurately controlled from 200 r. p. m. to 12,000 r. p. m.

The effect of disk speed was examined first. The motor speed was varied for different values of capacity in the condenser and readings taken of speed, high-frequency current, watts input to the transformer, primary voltage and primary current. Table 2 and the curve Fig. 8 are for a condenser of 0.005 mf., Table 3 and the curve Fig. 9 are for 0.01 mf. and Table 4 and Fig. 10 are for a condenser of 0.02 mf.

All three of these curves exhibit distinct maxima of current in the high-frequency circuit corresponding to certain critical motor speeds.

TABLE 3.

C—0.01 mf.

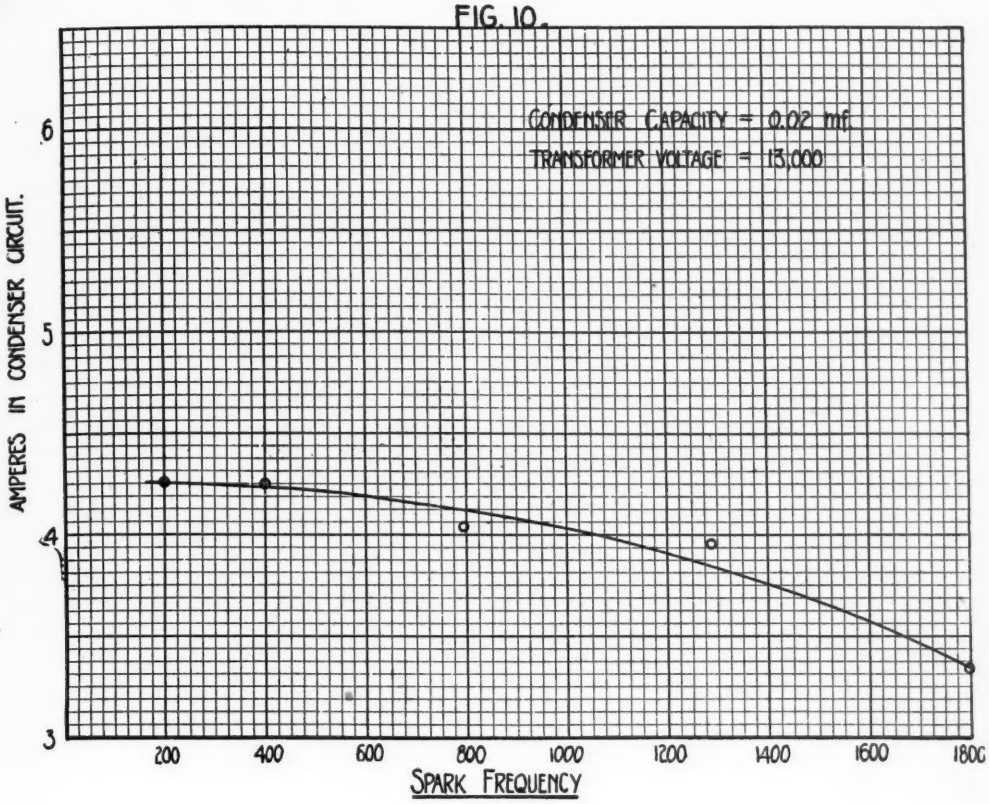
Motor Speed r.p.m.	I amps.	Watts.	Prim. amps.	Prim. Volts.
12,000	4.0	110	5.3	108
5,400	5.0	125	5.3	108
3,500	5.0	130	5.2	108
2,000	5.4	140	5.3	108
1,220	5.5	150	5.4	108
1,000	5.6	165	5.6	108
500	5.0	175	5.8	108

TABLE 4

C—0.02 mf.

Motor Speed r.p.m.	I amps.	Watts.	Prim. amps.	Prim. Volts.
12,000	3.0	96	5.3	108
6,400	4.0	115	5.4	108
4,000	4.0	115	5.4	108
2,000	4.5	124	5.4	108
1,000	4.5	135	5.5	108

FIG. 10.



Curve obtained with a transmitting set using a rotary gap in conjunction with a condenser of 0.02 mf.

DISTANCES COVERED BY PORTABLE WIRELESS SETS

ALTHOUGH there has been a great deal said about portable work, and although we see from time to time pictures of different types of portable outfits, very little has been published regarding the distance covered by the average outfit. Exception is made to the army outfits for, though we hear but little regarding their work, it is known that the sets used are practicable and efficient. It is proposed to cover in this article two items regarding practical "portable work," which will give an idea of what may be done with limited apparatus.

While in each test the apparatus used was of different make than the other, both outfits were of the loose coupled pattern, galena was used as mineral, and a 2,000-ohm headset completed the equipment. No fixed or variable condenser was used, so the outfits consisted of a loose coupler, 'phones and detector.

On the route known as the "Mariposa Trail" to Yosemite Valley, Cal., a wireless set as above set forth was carried along with the camping equipment. At about a distance of 125 miles from San Francisco, a single copper wire 100 feet

long was run up into a pine tree to a height of 50 feet, the other end being stretched to the instrument. At night time, San Francisco, Mare Island and numerous coastwise ships were copied without trouble, despite the fact that the location was in the Sierra Nevada mountains, and in the worst spot possible for the reception of messages, a small valley formed by the sharp high slopes of two ranges. This will give the camper who contemplates carrying a portable wireless outfit with him an idea of what kind of work he can do under unfavorable conditions and small aerial. On the peak of the range, and with an aerial supported from the top of a tall tree, it would be possible to do much better work.

The other test was on a single wire 100 feet long and 10 feet high the entire length. The set used was one especially designed for portable work, and weighed but one pound and a half. With this aerial, Mare Island was copied a distance of 50 miles, and on a very high wave. The signals were clear and readable, the time being about 2 P. M.

Those who have thought of the buzzer as a rather primitive means of sending will do well to ponder over the results of some of our ships in Asiatic waters. The buzzer was a bell of the 110-volt type minus the gong. With this as the only sending power, distances of 125 miles were covered without trouble, and it is claimed that this is no unusual range.—PAUL OARD.

A Research Club Formed by Wireless Amateurs

There has recently been formed at Shreveport, La., a research club by the local wireless amateurs. The members of the club are directed in their activities by Mr. C. D. Simmons, their instructor, who is a thorough master of radio telegraphy. Correspondence from wireless organizations and interested individuals should be addressed to Willie Antony, 1906 Laurel St., Shreveport, La.

The Bronx Radio Club of New York

There has recently been formed the Bronx Radio Club of New York, which has for its object the promotion of good fellowship among the amateurs of the Bronx. The club consists of eight enthusiastic members, most of whom have stations of their own. Members who wish to broaden their knowledge on the subject are instructed by the more advanced members. The present officers are as follows: President, M. Haber; vice-president, H. Berlin; secretary, L. Brodie; treasurer, A. Richter, and business manager, J. Smith.

The club will be glad to communicate with other similar organizations and individuals. All correspondence should be addressed to L. Brodie, 1382 Boston Road, Bronx, New York. Those wishing to call in person may see the president at 670 East 170th St., Bronx, New York.

The Killington Radio Club

At the last monthly meeting of the Killington Radio Club of Rutland, Vt., the following officers were elected: President and secretary, Raymond H. Shaw; vice-president and treasurer, Reginald P. Lyman; chief operator, Bruce Mills. All communications should be addressed to the secretary at 10 East Washington St., Rutland, Vt.

The Gem City Radio Association

The Gem City Radio Association of Dayton, Ohio, held its first meeting at the home of Frank Caswell, 21 DeKalb St., on July 17, 1915. The meeting was well attended. The association invites all those interested in wireless to join, and correspondence may be addressed to the president, Frank Caswell, at the above-mentioned address.

The Construction of a Variometer

By Charles Horton

IN the early days of wireless reception all adjustments as to inductance, capacity and coupling were made as nearly continuous as possible. For instance, in the case of inductance it was accomplished by the use of sliders riding over bared wire. As time passed and the degree of accuracy and other features became apparent, point contact switches began to take the place of sliders, and continuous adjustment gave way to step adjustment.

Step adjustments served their purposes well in cases where ordinary adjustment was required, but at the present moment, due to the sudden remarkable increase of receiving radius, these step adjustments are in danger of becoming obsolete and, no doubt, in due time all adjustments will again be continuous, but with this difference: Up-to-date continuous adjustments will not be subject to the disadvantages of the old types and, further, they will be more nearly, or actually, perfectly continuous.

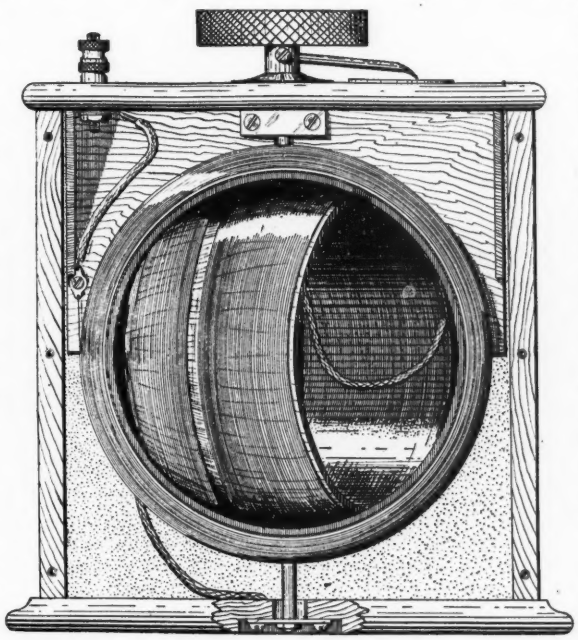


Fig. 1.—A view of the stationary and movable spools of the variometer.

As a type of these continuous adjustment instruments, the well-known variometer may be cited. This instrument, as is well known, takes the place of the widely used loading coil, to which, of course, it is superior. The rotary adjustment of this instrument is also a great advantage over the loading coil. In addition, it may here be stated that the trend in receiving instruments is distinctly toward all rotary adjustments, since these are infinitely superior to all others.

Although the variometer is by no means new, it has not come into widespread use among amateurs, probably owing to the difficulties involved in its construction. In order to produce a variometer of any efficiency and range it is necessary to use portions of spheres upon which to wind the coils in order to obtain the minimum of separation between the coils and yet allow of a complete half turn to one coil within the other. The variometer is commonly constructed so that the inside coil may move from a position within the plane of the outside coil to a position at right angles to that plane and thence to a second position again within the plane of the outside coil. Thus the movable coil of the variometer proceeds through a rotation of 180 degrees from a position of common neutralization in conjunction with the fixed coil, to a position of no mutual action and finally to a position of co-operation, thereby rendering possible a wide and continuous variation.

The drawings accompanying this article give the construction of a very fine variometer and show clearly the method used to make the spherical coil forms. The making of the latter has been the great stumbling block to successful construction.

Fig. 1 shows the variometer assem-

bled in the containing case, the side having been removed to show the coils. The inner coil is shown moved into an angular position relative to the outer coil.

Fig. 2 represents a front view of the instrument with the front panel removed, and with the coils turned at right angles to each other. There is also indicated the method of mounting the stationary coil upon the interior of the top panel.

Fig. 3 is a view of the coils mounted on the top panel of the case, looking up from the bottom. The bearing plate at the bottom of the instrument is clearly indicated, and is intended to be screwed into a recess in the base of the instrument in such a way as to allow sliding motion in any direction under the heads of its securing screws, thus obviating the necessity of accurate machine work in preventing the coils from touching each other.

Fig. 4 is a view of the top of the instrument, showing the scale and other details.

The steps in making the variometer are illustrated in the detailed drawings as follows:

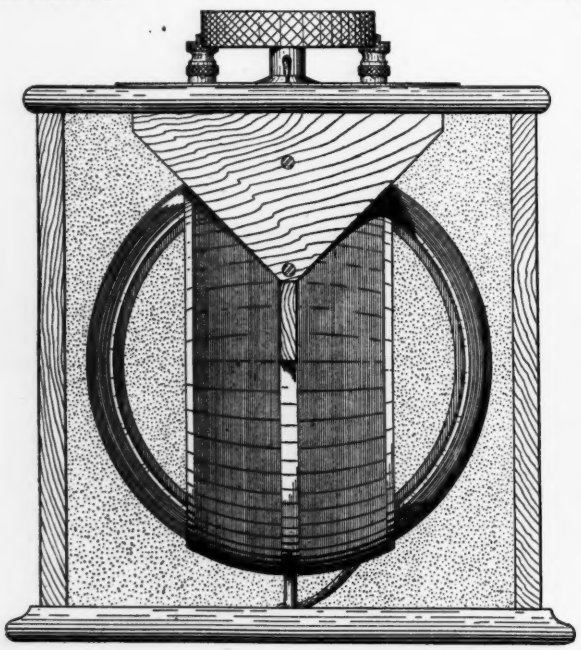


Fig. 2.—Front view of the variometer with the front panel removed and with the spools turned at right angles to each other.

Detail No. 1 shows to scale the top of the containing case which should be made of mahogany, oak or other suitable wood and polished by the application of several coats of shellac or varnish, and finished off with pumice stone and water in the usual way.

Detail No. 2 is the bottom of the case, which needs only to be polished at the edges. The recess shown at the bottom of this piece should be accurately made, as the bottom bearing plate rests within it.

Detail No. 3 is the front and back of the case, which should, of course, be polished in the same manner as the front.

Detail No. 4 shows the two sides, which complete the case. The case is assembled by means of countersunk screws, which, if they can be secured, should be of the type known as "Oval head," the appearance of the set being materially improved since these screws are slightly rounded on top.

Detail No. 5 is the support for the stationary coil, and should be carefully made, since the position of the stationary coil is of great importance.

Detail No. 6 shows the angle pieces used to support the parts (Detail No. 5) that support the stationary coil in a position at right angles to the top panel of the case. Care should be taken to make these pieces absolutely square. They should also be exactly alike. Both details, Nos. 5 and 6, are specified as hard rubber, but if need be the builder can use some close grained wood such as maple, mahogany or olive wood.

Detail No. 7 shows the form for the inner or movable coil. The form is made of wood turned in the lathe. The coil can be made of paper, if desired, similarly to the stationary coil form to be described later. As soon as this piece is taken from the lathe it should be shellacked to prevent the entrance of moisture into the wood and the consequent distortion.

Details Nos. 8, 9 and 10 show the shaft of the variometer, which is to be made in two parts which are insulated from each other by a hard rubber bushing. This is done in order to provide two conductors in the shaft for the connecting of the coils. The small brass bushings shown are held on the shaft in any position desired by their set-screws, and are intended to be placed snug against the inside walls of the movable coil so as to position the coil on the shaft. It is obvious that by this means the movable coil can be placed so as to rotate freely within the stationary coil. The lower end of the shaft is threaded for an 8-32 nut.

Detail No. 10 is the bottom bearing plate. The screws for holding this plate to the bottom of the case are intended to fit loosely in the holes at the corner of the plate to permit adjustment back and forth.

Detail No. 11 is the upper bearing for the shaft, and is made of 1/16-inch brass and one piece of ¼-inch square brass with a hole drilled in it. These pieces are carefully soldered together, forming a part that is intended to span the two pieces shown in Detail No. 5, to which it is screwed.

Detail No. 13 is the regulating knob, made of hard rubber, or wood, treated with a coat of asphalt varnish.

Detail No. 14 is the spring washer, to be inserted under the knob, in order to keep the movable coil in any position desired and prevent accidental change in adjustment.

Detail No. 15 is the stationary coil form, which is made as follows: There is first turned on the lathe, or otherwise made, a spool or bobbin of wood, as shown in Detail No. 16. The spool is given a coat of shellac and then covered across from one end piece to the other with a piece of veneer or thin metal. Next, through a hole placed conveniently, plaster of paris is poured till the space inside is full, then the form is thoroughly dried. The plaster should be mixed with plenty of water so that it is the consistency of thick soup. The form should be dried for three or four days. When the plaster is perfectly dry so that it can be scraped off as a dry powder, the covering of veneer or metal is removed and the whole affair again set up in the lathe on the centers previously used and the plaster turned down truly spherical and to the specified size. If a template of thin sheet metal is used to get the spherical shape this operation is made much easier.

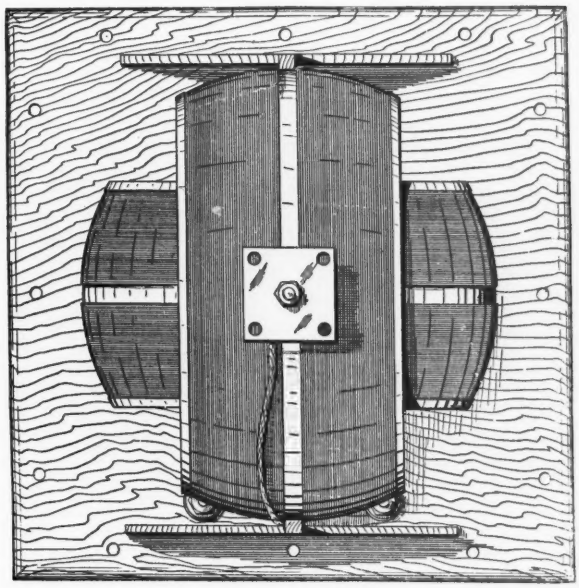


Fig. 3.—View of the coils mounted on the top panel of the case, looking up from the bottom.

The next step is to secure a small quantity of the paper, known to the trade as "red pattern" paper, and which can be bought at almost any wholesale wrapping paper house. It should be of a thin grade. The paper is cut into strips 3½ inches wide, and as long as possible. A tin template is then provided of the size and shape shown in Detail No. 17, and cut with notch, as indicated. The form shown in Detail No. 16 is now covered with a coat of parafine over the plaster, so that the paper can be released from it, and the notched paper strip wound about it in spherical form with a liberal amount of hot carpenter's glue applied with a brush. Care should be taken that the lobes of the notched strip are prevented from lapping over one another; they should lie flat and just in contact.

As the winding of the strip reaches the end of one piece the entire winding should be tightly wound with string or wire to cause it to assume the spherical shape of the plaster form. Then, with the string tightly secured about it, the winding should be set aside until the glue is dry. The string is then removed and a second strip, cut the same as before, is carefully butted up against the end of the first strip and the winding proceeds. It will be noted that the

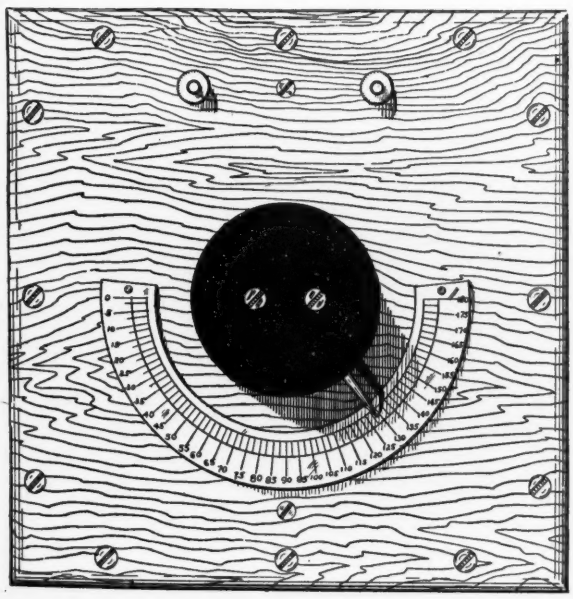


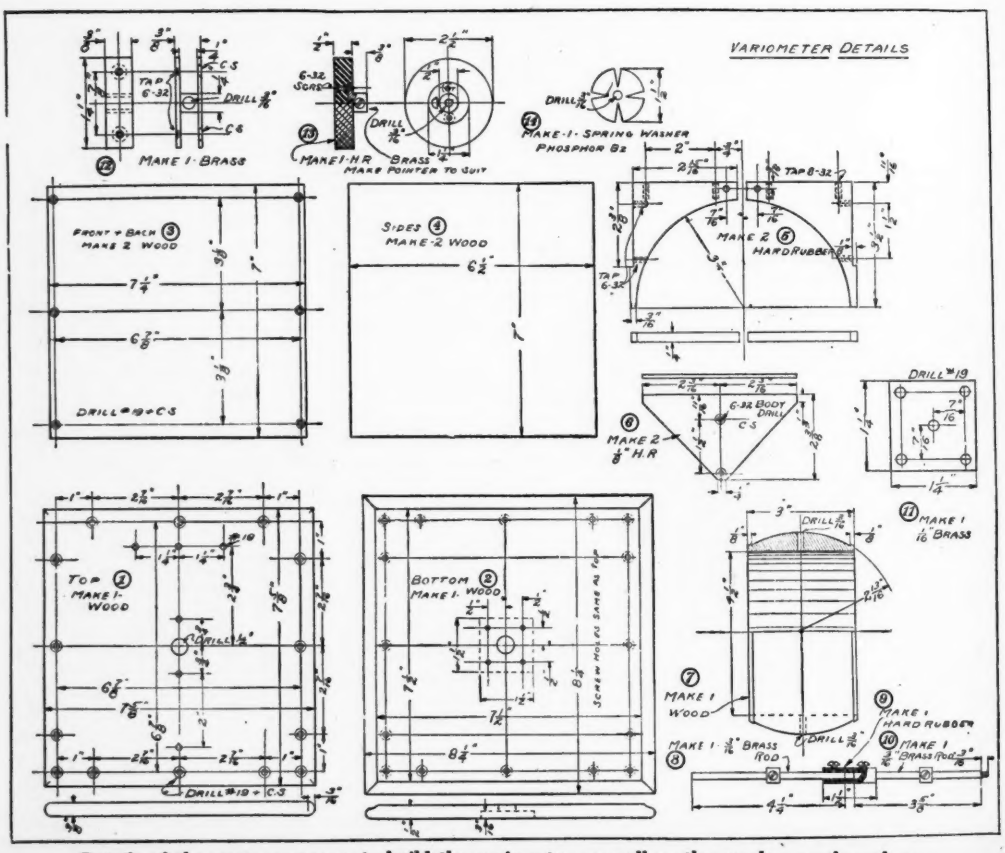
Fig. 4.—Top view of the variometer case, showing the handle, binding posts and graduated scale.

lobes of the cut strips do not agree from one layer to another, and for that reason the glue is applied pretty liberally to make the layers uniform. One strip at a time is put on as described until the thickness of the shell is 3/32". After drying the ends of the form are removed and the paper shell, after having been neatly cut around its greatest diameter into two parts, is removed from the form. It may be necessary to heat the affair in order to loosen the shells.

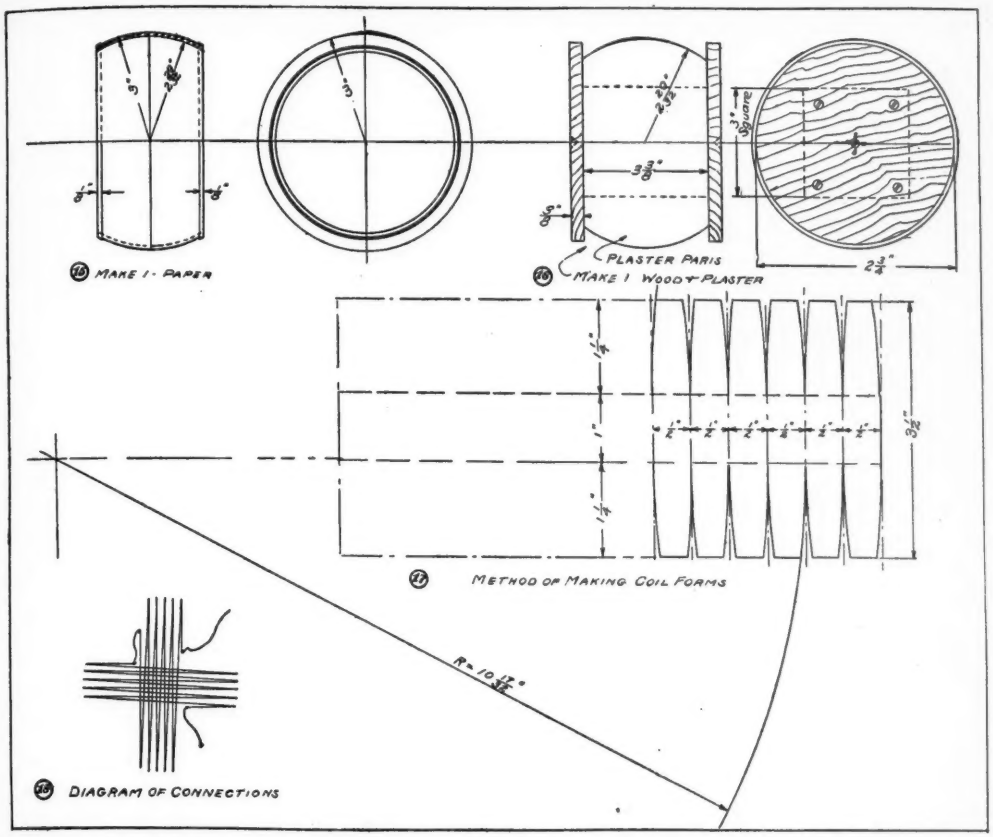
The shells should now be cut down to a width of 1½" with a very sharp knife and holes made at their largest diameters for the shaft to pass through. The final operation is the gluing of a ⅛" paper strip on the shells at each small diameter, as shown, for the purpose of providing a base for winding the wire on, and applying a coat of asphalt varnish all over.

The winding of the wire on the forms may be conveniently accomplished by mounting the shells on the plaster form without the ends on and securing the shells in true position by means of small brads forced through them into the plaster. The winding should proceed in the usual manner, beginning in the case of each shell at the narrow retaining strip; that is to say, at the small diameter. Care should, of course, be taken upon the completion of the winding of one shell to take the form from the lathe and reverse it between the centers in order that the direction of winding on the two shells shall be the same. The wire should not quite fill the shells. A strip about 3/16" should be left unwound on each shell at its greatest diameter in order to allow space for mounting. The outside coil or stationary coil should best be wound with No. 20 single cotton-covered magnet wire, preferably left dry except that the covering may be stained green if desired with an *alcohol stain*. Water stain should not be used. The reason that no shellac or varnish is used is on account of the great increase of distributive capacity due to this material. If a particularly fine instrument is projected, green silk-covered wire is very attractive. The inner coil is easily wound similar to the shells by centering in a lathe by means of a wood chuck or any other convenient manner. One-half of the coil is wound to within 3/16" of the greatest diameter (which is best marked while turning). The coil is then reversed in the lathe and the other half wound. This coil also should be left dry.

The manner of assembling is as follows:


VARIOMETER DETAILS
MAKE 1 BRASS
MAKE 1 H.R. BRASS
MAKE POINTER TO SUIT
MAKE 1 SPRING WASHER PHOSPHOR BZ
FRONT & BACK MAKE 2 WOOD
SIDES MAKE 2 WOOD
MAKE 2 HARD RUBBER
MAKE 2 H.R.
TOP MAKE 1 WOOD
BOTTOM MAKE 1 WOOD
MAKE 1 BRASS ROD
MAKE 1 HARD RUBBER
MAKE 1 BRASS ROD

Details of the parts necessary to build the variometer, as well as the wooden spools and case.



Details of the winding forms and the method of making them, as well as a wiring diagram of the variometer.

The pieces, Detail No. 5, are first mounted in proper position on the under side of the top of the case; Detail No. 1, and then one of the shells, Detail 15, is mounted in the circular parts by means of very small brass screws. Next, the movable coil is loosely placed into this shell and then the other shell put on and screwed to its support with the small screws, and also attached to the other shell by means of a piece of passepartout strip, which gives the neat appearance of leather.

The next operation is to slip the shafts, Details 8 and 10, through both the coils and bring the ends almost together within the hard rubber tube, Detail 9. The two shafts are fastened within the tube by means of the set-screws provided. The shaft thus completed will then be extending through the cover piece and out at the bottom of the coils.

The next step is to make the electrical connections, which are within the two coils. This is done so that the path of the current will be as follows:

From one of the binding posts to one of the small ends of the stationary coil (see Fig. 1), thence across that winding, and by means of a flexible lead, to the lower bearing plate, from this bearing up through the shaft, Detail 10, by means of a second flexible lead from this shaft to one end of the movable coil, across that winding, by means of a third flexible lead to the other part of the shaft, Detail 8, thence to the upper bearing and by a fourth flexible lead to the other binding post. It is obviously not important which end of the stationary coil lead is connected to the end of the movable coil, since the coils make a complete half revolution in operation and thus are at one time in opposition and at another time in co-operation. All the joints should be carefully made and soldered.

When the connections have been made, the case is partially assembled by screwing to the base, Detail 1, the two side pieces, Detail 4, and then screwing thereto the top piece with the two coils attached thereto; the shaft being allowed to project through the hole in the base piece. Next, the bearing plate is put on the lower end of the shaft and a nut screwed on to hold it in place. A drop of solder on this nut will insure that it does not come loose. The bearing plate is then screwed to the base in such a manner that it can be forced in any direction under the heads of the screws. The upper bearing has, of course, been put on when the coils were mounted and the spring washer is now slipped over the up-

per end of the shaft and the knob at the top. By means of all the adjustments provided the shaft is caused to rotate stiffly in its bearings, and by means of the two collars on the shaft inside the movable coil the latter is spaced away from the stationary coil so as to permit of free rotation. When all adjustments have been accomplished and the connections made to the binding posts, the front and back of the case may be screwed in place and the instrument is complete. Finally, the scale should be applied after the instrument has been tested to determine which is the zero inductance point. Either end of the swing may be made the zero point if the coils are carefully connected to produce the desired result. This device will undoubtedly give good satisfaction.

The Central Radio Association Blue Book

The Central Radio Association, which covers over thirty states, announces that some supplementary pages have been added to the Blue Book which they publish, in order to bring it up to date for the fall and winter season. The names of all the new members are being added as well as a considerable fund of interesting articles, among them contributions from the pen of A. Hoyt Taylor, Ph.D., director of the radio station of the University of North Dakota.

The Blue Book of the Central Radio Association contains a list of names, addresses and call letters of hundreds of amateurs, as well as complete information in regard to their station. It also includes the call letters of all the principal government and naval stations. One of the interesting features is a key to the station calls of the world. Other features are a list of authorized abbreviations used in radio communication, as well as dozens of short cuts in general use; instructions concerning a government radio license—how and where it can be secured; complete descriptions of the audion detector and audion amplifier; information concerning the government time signals and weather reports, as well as the meaning of every code figure; the average transmitting distance of different sized spark coils; how to build an oil insulated condenser of any size up to five KW; how wireless stations are tuned, giving in detail the various steps in tuning a transmitting set in order to secure the greatest radiation; the proper form to use in calling a station to send a message; articles on the reception of continuous waves, the ultra-audion and the double audion, and a number of other equally interesting subjects.

The price of the book is fifty cents postpaid, and a copy can be secured by addressing H. B. Williams, secretary, Central Radio Association, Chanute, Kansas.

New Uses for Radio-Telegraphy In Life Saving

The application of radio-telegraphy to motor-lifeboats, inaugurated to a limited extent last year, has been an advance of great importance, not only as a factor lessening the danger to life at sea, but also as a great aid to navigation. In dense fog or in the presence of ice, a lifeboat equipped with a radio telegraph apparatus is sent out ahead of the steamer; and by means of the radio signals, the parent vessel is able to follow in perfect security. In many cases when a person has fallen overboard from a steamer, the officer in the small boat sent out to pick him up is unable to find him, while from the bridge or crow's-nest of the steamer, the man struggling in the water is clearly visible. In case of an accident aboard the steamer of so serious a nature that the ship's crew were forced to take to the lifeboats they would no longer be forced to make the feeble and inefficient efforts to attract the attention of a passing ship that are often the horror of the present-day shipwreck.

A new electrical machine will scour 2,000 pans in an hour and grease them for use again.

About 25,000,000 horse-power is developed in the explosion from one of the biggest cannon now in use.